RESTAURANT FOOD ENVIRONMENTS IN SASKATOON FOR CHILDREN

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ABSTRACT

In response to the rising prevalence of childhood overweight and obesity in Canada and around the world, the food environment has been recognized as one important determinant of health status. In order to fill some existing knowledge gaps in Canadian food environment research to better understand factors that may lead to health disparities, as well as to develop healthy public policies in response, this study characterized food environments in restaurants for children (10-13 years) living in Saskatoon, and examined their associations with neighbourhood socioeconomic characteristics. Specifically, using GIS-based techniques and a structured observation tool (NEMS-R), it examined community and consumer restaurant food environments by neighbourhoods categorized by distress level. The distribution of different restaurant types differs with respect to neighbourhood distress level. According to NEMS-R results, significant differences were found in the healthfulness of foods and beverages offered in restaurants by different categories. Restaurants within lower distress level neighbourhoods presented higher (more healthful) NEMS-R scores. However, the fast food environment for children was not significantly different according to their neighbourhood distress level.

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CHAPTER 1
INTRODUCTION

Background

In recent decades, the prevalence of obesity has increased dramatically in Canada and around the world, and is reaching epidemic proportions among children (Ball & MaCargar, 2003; Gillilan et al., 2012). The increase in overweight or obese children is a significant public health concern because it is associated with chronic diseases, childhood morbidity, and adverse social outcomes; and, being overweight or obese in childhood has potential life-long implications (Collins et al., 2011; Inge et al., 2013). Although obesity has been linked to both individual and environmental factors, it is the effect of the latter on health behaviour that appears to be instrumental in the rapid development of the epidemic (Rahman, Cushing, & Jackson, 2011; Razani & Tester, 2010). There has been an increased interest in understanding the role of the built environment as a potentially important determinant in shaping childhood health status in ways that may promote obesity-related behaviours, such as physical inactivity (DeBate et al., 2011; Rao, Prasad, Adshead, & Tissera, 2007; Salois, 2012) and unhealthy diets (Glanz, Sallis, Saelens, & Frank, 2007; Van Hulst et al., 2012).

A number of factors contribute to children's dietary behaviours, including personal preferences, parental influences, accessibility of food options, and socioeconomic status (Dubois, Farmer, Girard, & Peterson, 2007; Rodenburg, Kremers, Oenema, & Mheen, 2012). There is growing evidence that those of lower socioeconomic status have to spend a greater proportion of their income on food and tend to consume

less healthy diets (Macdonald, Cummins, & Macintyre, 2007; Shier, An, & Sturm, 2012). In addition, it has been suggested that residents of socioeconomically distressed neighbourhoods have greater exposure, compared to those living in more affluent areas, to certain environmental factors, which might contribute to the development of unhealthy eating habits. Food consumed in restaurants, especially increased consumption of fast food, is positively related to weight gain and childhood obesity (Batada, Bruening, Marchlewicz, Story, & Wootan, 2012; Skidmore et al., 2010), and it has been hypothesized that fast food restaurants and other types of food outlets which sell energy-dense, high-fat products might be more prevalent in socioeconomically distressed areas (Black, Carpiano, Fleming, & Lauster, 2011). Greater concentrations of fast food outlets in these areas, which may increase the consumption of unhealthy food, may contribute to higher obesity prevalence among economically disadvantaged populations.

However, a limited number of studies have assessed the relationship between food environments, particularly in restaurants, and neighbourhood socioeconomic characteristics (Caspi, Sorensen, Subramanian, & Kawachi, 2012; Fleischhacker, Evenson, Rodriguez, & Ammerman, 2011; Macdonald et al., 2007). This study is therefore intended to contribute to the existing literature on neighbourhood effects and childhood obesity. Specifically, it aims to fill some knowledge gaps in Canadian food environment research to better understand factors that may contribute to health disparities and to developing healthy public policies in response.

Definition of Terms

Food Environment

"The food environment can be broadly conceptualized to include any opportunity to obtain food. This definition of the food environment can include physical, socio-cultural, economic and policy factors at both micro- and macro-levels." (Townshend & Lake, 2009, p. 910). It also includes the accessibility and availability of food, as well as marketing and advertising of food and food products (Glanz, Sallis, Saelens, & Frank, 2005). In this study, I choose to use the term 'food environment' interchangeably with the term 'nutrition environment' used in Glanz et al.'s model (2005).

Community Food Environment

The community food environment is composed of the number, type, location, and geographic accessibility of food outlets, such as convenience stores, supermarkets, fast food restaurants, and full-service restaurants (Glanz et al., 2005).

Consumer Food Environment

This is the environment consumers experience within food outlets including restaurants, which differ appreciably, and could be influencing patrons' eating patterns (Glanz et al., 2005). For example, in a consumer food environment, features include the availability of healthy food offered, types of food being promoted, and the relative cost of nutritious foods compared to less nutritious foods.

Geographic Information Systems (GIS)

Geographic Information Systems integrate hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information (Riner, Cunningham, & Johnson, 2004).

Buffer

A buffer is a defined geographical distance or zone around a given location (such as a home, school, or food outlet address) (Charreire et al., 2010).

Geocoding

Geocoding is the process of finding associated geographic coordinates (often expressed as latitude and longitude) from other geographic data, such as street addresses, postal codes, the features of which can be mapped and entered in Geographic Information Systems (Krieger et al., 2003; Rushton et al., 2006).

Nutrition Environment Measures Survey for Restaurants (NEMS-R)

NEMS-R is a structured observational tool that assesses the relative healthfulness of foods and beverages available on main and children's menus and indicators that may support or challenge healthful eating in restaurants (Saelens, Glanz, Sallis, & Frank, 2007).

Sit-down Restaurant

Sit-down restaurants include restaurants that offer full table service by wait staff, and cafeteria sit-down restaurants where customers go to serving counters/stalls to pick up their food (Saelens et al., 2007).

Coffee Shop

This category includes restaurants where coffee and/or baked good/ pastries are the main items sold (Saelens et al., 2007).

Fast Food Restaurant

A fast food restaurant is characterized by no or minimal table service and by food that is cooked at least in part in advance and is supplied quickly after ordering (Saelens et al., 2007).

Purpose of the Study

Using Geographic Information Systems (GIS) and the Nutrition Environment Measures Survey for Restaurants (NEMS-R), the purpose of this study is to characterize neighbourhood food environments, particularly in restaurants, for children between the ages of 10-13 years living in Saskatoon neighbourhoods, and to examine their associations with neighbourhood socioeconomic characteristics.

The following research questions are addressed in this study:

1) What is the distribution of various restaurant types (community food environment), including sit-down restaurants, coffee shops, and fast food restaurants, in Saskatoon neighbourhoods?

2) What are the differences of the healthfulness in different types of restaurants (consumer food environment), as measured by Nutrition Environment Measures Survey for Restaurants, by neighbourhood socioeconomic characteristics?

3) What is the fast food environment around 10 to 13 year old children's home locations, and what is the association with their home neighbourhood socioeconomic characteristics?

The dramatic changes in the built environment over recent decades have contributed to changes in human behaviours that might contribute to explaining the rapid increase in the prevalence of overweight and obese children (Booth, Pinkston, & Poston, 2005; Papas et al., 2007; Razani & Tester, 2010). Recent evidence suggests the important role of food environments as a source of influence on community and population health via eating behaviours that lead to an increased risk of obesity (Carroll-Scott et al., 2013;

He et al., 2012). While some studies have focused on the relationships between food environments and obesity among children and adolescents by investigating how neighbourhood characteristics may promote or hinder eating patterns (Gilliland et al., 2012; Lee, 2012; Salois, 2012), there remains a great need to better examine dimensions of food environments and whether differences exist across neighbourhoods by their socioeconomic characteristics.

The Saskatoon Health Region contributed to examination of Saskatoon's food environment with preliminary research focusing on the geography of supermarkets and fast food outlets in Saskatoon neighbourhoods (Kershaw, Creighton, & Markham, 2010). However, there has not been an in-depth characterization of restaurant food environments by neighbourhood socioeconomic characteristics. The current study therefore adds to the knowledge base by using GIS techniques and an observational tool (NEMS-R) to study the restaurant food environments, with an emphasis on fast food environments, for children living in Saskatoon, by neighbourhood socioeconomic characteristics.

Theoretical Perspectives

Researchers have used several ecological frameworks to describe the multiple levels of food and nutrition environments (Health Canada, 2013). The *Community Nutrition Environments Model*, developed by Glanz et al. (2005), was based on an ecological model of health behaviour (Booth et al., 2001; Sallis and Owen, 2006). It incorporates constructs from the fields of public health, health psychology, consumer psychology, and urban planning, and identifies four sub-environments: community, organization, consumer, and informational nutrition environments, which together influence eating patterns, moderated or mediated through psychosocial, demographic, and

perceived environment variables (see Appendix A). While each level impacts individual behaviours, the community and consumer environments have been recognized as high research priorities owing to their potentially far-reaching effects on health (Glanz et al., 2005).

The theoretical model of this study (see Figure 1-1. Model of Restaurant Food Environments) is adapted from Glanz et al. (2005), due to its ability to instruct the examination of food environment variables in key domains. In recent years, several studies have examined geographic access to food outlets, including food stores and restaurants, and have documented community- or neighbourhood-level associations related to socioeconomic, and ethnic/racial patterns (Bauer, Larson, Nelson, Story, & Neumark-Sztainer, 2009; Fleischhacker et al., 2011). For instance, fast food restaurants are more prevalent in ethnic minority or lower income neighbourhoods (Block, Scribner, & DeSalvo, 2004; Morland, Wing, Diez Roux, & Poole, 2002), whereas some healthy foods, such as fruits and vegetables, are less prevalent (Ding et al., 2012). Others have examined correlations between neighbourhood characteristics and individual food behaviours, some of which might also explain the socioeconomic disparities in nutrition and health outcomes (Fraser, Clarke, Cade, & Edwards, 2012; Veugelers, Sithole, Zhang, & Muhajarine, 2008). Therefore the model used in this study incorporates the socioeconomic characteristics of neighbourhoods that are hypothesized to be related to restaurant food environments and to be important for promoting or hindering healthy eating behaviours.

Building from the Glanz et al. (2005) model, the current study frames the incorporation of features of restaurant food environments and how these are related to

eating patterns. Environmental characteristics could directly influence, or indirectly be moderated by, individual variables (e.g. genetic, physiological, and social cognitive) to encourage or discourage healthy eating behaviours, which in turn impact chronic disease risk, and specifically overweight and obesity. The *community food environment* describes the geographic distribution of restaurants, that is, the number, type, location, and accessibility of food service outlets. In contrast, the *consumer food environment* describes what consumers encounter inside a restaurant, including the nutritional quality, price, and availability of foods and beverages offered, as well as facilitators and barriers to healthy eating within the food outlet (Glanz et al., 2005). Neighbourhood socioeconomic characteristics, such as income and ethnic mix, are seen as one of the environmental constructs mediating the potential impact of food environment variables on eating outcomes.

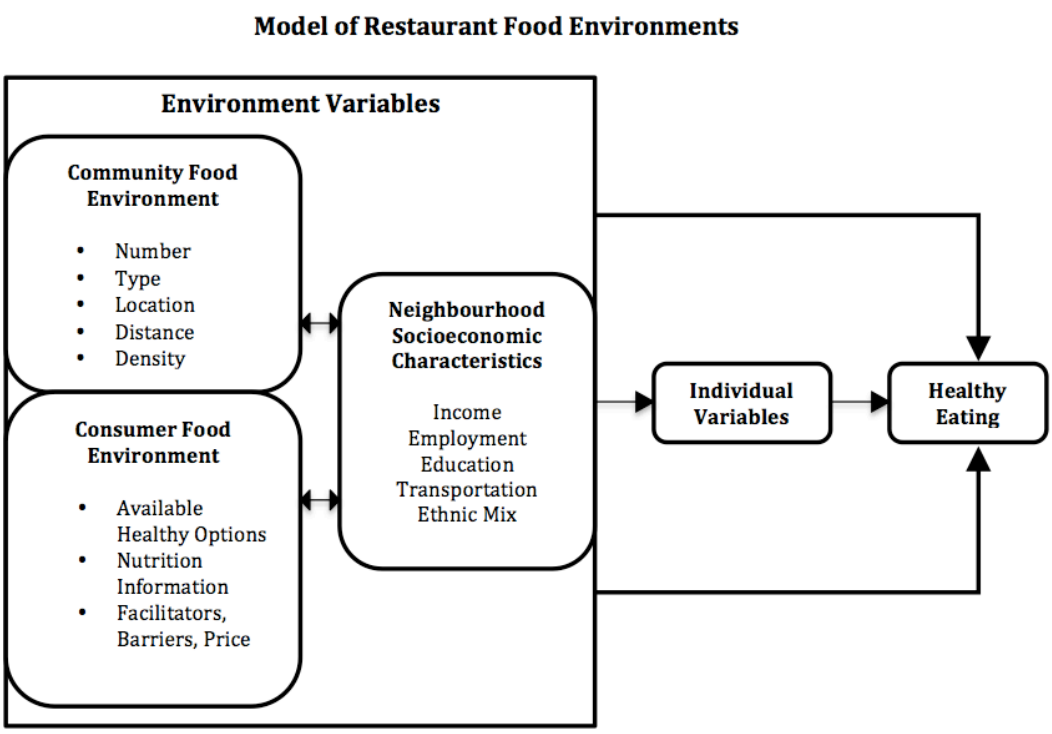


Figure 1-1. Model of restaurant food environments (adapted from Glanz et al., 2005)

Significance of the Study

Examination of food environments and their potential impact on healthy eating behaviours is important for informing interventions in policy and practice aimed at the prevention of childhood overweight and obesity. Through characterization of food environments, including measurement of restaurant distribution, accessibility, and the relative healthfulness of food available, this study will result in a number of policy recommendations that aim to improve access to healthy food options and discourage unhealthy food choices in restaurants. With its focus is on the city of Saskatoon, the study findings will make an important contribution to understanding the food environment in a mid-size Canadian city, and establish a foundation for future research and evidence-based practice, as well as policy-making to support healthy eating behaviours for children. It

will also contribute to the examination of factors that may lead to health disparities through its focus on linking food environments with socioeconomic characteristics in Saskatoon's residential neighbourhoods. In addition, specific examination of fast food environments for children in relation to neighbourhood socioeconomic characteristics will aid in developing prevention guidelines for childhood obesity, as related to accessibility and availability of fast food outlets.

CHAPTER 2
LITERATURE REVIEW

Introduction

Childhood overweight and obesity have reached epidemic proportions and represent a serious public health problem in Canada and around the world, with negative physical, social, and mental health consequences (Han, Lawlor, & Kimm, 2010; Rahman et al., 2011). There has been a dramatic increase in unhealthy weight in children: in 1978, only 15% of children were overweight or obese; by 2007, 29% of children and adolescents had unhealthy weights (Statistic Canada, 2012). A recent survey, using World Health Organization standards of measurement, reported that 31.5% of Canadian children (five to 11 years old) - an estimated 1.6 million Canadians - were classified as overweight (19.8%) or obese (11.7%) (Roberts, Shields, Groh, Aziz & Gilbert, 2012). Obesity in children is associated with increased morbidity and mortality along with increased risk of a number of diseases and health disorders, including high blood pressure, type-2 diabetes, asthma, cardiovascular disease, and certain cancers (Ball & McCargar, 2003; Collins et al., 2011). In addition, being overweight and obese in childhood is likely to extend to adolescence and adulthood, which is associated with poor economic outcomes, lower education attainment, and psychosocial repercussions, such as social discrimination, poor self-esteem, depression, and criminal behaviours (Inge et al., 2013). Given the detrimental health consequences of childhood obesity and rapidly rising rates, successful prevention intervention efforts are urgently needed.

Important research on the causes of childhood obesity has focused on the role of individual factors (i.e., age, gender, and race/ethnicity) and how these are influenced by demographic and socioeconomic characteristics (i.e., genetics, physiology, household income, and parental education) (Haynos & O'Donohue, 2012). For example, children or adolescents living in low income or low educational attainment households are more likely to be obese compared to their peers, but the relationship is not consistent across race and ethnicity groups (Amarasinghe, D'Souza, Brown, Oh, & Borisova, 2009; Brown & Siahpush, 2007). However, there is consensus that research on individual-level associations with childhood obesity does not fully explain current obesity trends, given that individual factors are embedded within environmental contexts, which may play a significant role in shaping children's health (Davison & Birch, 2001; Papas et al., 2007). Fundamentally, increasing rates of childhood obesity are likely resulting from sustained energy imbalances that occur when energy consumption exceeds energy expenditure. The built environment, as presently conceptualized in the health literature, affects energy imbalance by facilitating or hindering physical activity (Tremblay, 2007) and adherence to a healthy diet (Navalpotro et al., 2012). Two systematic reviews (Booth et al., 2005; Papas et al., 2007) found significant evidence linking obesity to some aspects of the built environment, such as land use mix, walkability, and access to various food outlets, in most studies they reviewed. Healthy dietary behaviours, particularly, are central to overall health and reduce the risk of nutrition-related chronic diseases including obesity (Skouteris, McCabe, Swinburn, & Hill, 2010). To maintain healthy eating patterns, access to safe, acceptable, and nutritious foods is a priority for children. Therefore, researchers are increasingly examining environmental determinants of individual

behaviors in a causal pathway of obesity (Papas et al., 2007). For example, accessibility and availability of food retailers have been shown to be important components of the built environment that may have impact on individual food choices (Story, Kaphingst, Robinson-O'Brien, & Glanz, 2007).

Consumption of meals away from home is very common and some aspects of restaurant meals, such as large portion sizes and added sugar, have been linked to increased risk of obesity (Batada et al., 2012; Bauer et al., 2009; Cerin et al., 2011). Epidemiological evidence also suggests that specific eating behaviours, for example, consumption of energy-dense and high-fat food in restaurants, contributes to unhealthy weight gain (Poskitt, 2005; Vernarelli, Mitchell, Hartman, & Rolls, 2011). Increased consumption of fast food in North America is an eating behaviour that has become common among children; it has been associated with poorer dietary profiles, such as higher consumption of energy from fat and soft drinks and lower consumption of fruit and vegetables, and therefore negative health implications related to weight gain and childhood obesity (Austin, Melly, Sanchez, & Patel, 2005; Batada et al., 2012). Several studies have found that greater access to fast food outlets at the neighbourhood level may influence food consumption trends for those vulnerable groups with fewer resources for travelling further to purchase food (Burdette & Whitaker, 2004; Downs et al., 2009).

This review of the literature examines the food environment and its relationship with neighbourhood socioeconomic characteristics. The first section addresses research on aspects of the food environment as a determinant of childhood overweight and obesity; the second section focuses on studies examining the relationship between

restaurant food environments and eating behaviours; and the third section discusses food environment measurement and relevant challenges.

Food Environment Variables and Childhood Obesity

In recent years, research and public policy attention have increasingly focused on understanding and examining modifiable aspects of the built environment, which are drivers of, and potential solutions to, the problem of childhood overweight and obesity (Pate et al., 2013; Skidmore et al., 2010; Smith et al., 2010; Williams, Crockett, Harrison, & Thomas, 2012). There is evidence to show that long-term solutions to childhood obesity can be achieved by modifying the built environment to increase children's physical activity and consumption of nutritious foods, and to reduce their intake of unhealthy foods (Rahman et al., 2011; Sallis & Glanz, 2006). Relevant research has resulted in a number of policy recommendations and intervention programs that aim to improve environmental conditions that put children at risk for physical inactivity, sedentary behaviour, and poor diets (Penney, Almiron-Roig, Shearer, McIsaac, & Kirk, 2014). A recent report entitled "Prevention and Promotion and Curbing Childhood Obesity" has identified a policy priority of increasing the availability and accessibility of nutritious foods, particular for vulnerable populations (Health Canada, 2013).

Features of the built environment consist of urban design and neighbourhood characteristics such as residential density, land use mix, availability of public transportation, access to physical activity facilities, and various food outlets (Brownson, Hoehner, Day, Forsyth, & Sallis, 2009; Rahman et al., 2011; Razani & Tester, 2010). There is a growing body of literature focused on the contribution of the built environment features to obesity risk. For example, research found that neighbourhoods designed with

mixed land-use, which encourages walking, or accessible destinations, which discourage dependency on automobiles for transportation, increase residents' physical activity (DeBate et al., 2011; Sallis & Glanz, 2006); also that the presence of large grocery stores, such as supermarkets, is associated with lower childhood body mass index, whereas access to fast food outlets and convenience stores increases risk of overweight status (Khan, Calloway, Maida, & Rakel, 2012; Ohri-Vachaspati, Lloyd, DeLia, Tulloch, & Yedidia, 2013; Rahman et al., 2011). The built environment literature also emphasizes the significance of community- or neighbourhood-level determinants as explanations for physical activity, eating patterns, and health outcomes including obesity (Papas et al., 2007; Sallis et al., 2009; Wen & Kowaleski-Jones, 2012). The availability, accessibility, and cultural acceptability of food in a neighbourhood affect the health of the residents in that neighbourhood (Bodor, Rice, Farley, Swalm, & Rose, 2010; Brownson et al., 2009; Cerin et al., 2011). Significant inequalities have been documented in access to environments that support individual healthy behaviours, both related to food resources (Cerin et al., 2011) and recreational facilities (Shearer et al., 2012) among populations that carry a disproportionate burden of overweight or obesity. For example, lower socioeconomic status neighbourhoods are higher risk, since these communities may have fewer destinations within safe walking distance and fewer food stores with healthful and affordable options (Brownson et al., 2009; Cummins & Macintyre, 2006). While established evidence has linked the built environment to children's physical activity and food consumption, it has yet to conclude definitively that aspects of the built environment promote childhood obesity (Larsen & Gilliland, 2008; Lisabeth et al., 2010). For example, Sallis and Glanz (2006) have noted that recent changes in the nutrition

environment, such as greater reliance on convenience stores and fast food restaurants, expanding portion sizes, and a lack of access to fresh fruits and vegetables, are widely believed to contribute to childhood weight gain, but more evidence that positive changes in food environments will reduce rates of obesity is needed.

Aspects of the food environment, in particular, have been thought to play an important role in childhood obesity by influencing children's daily dietary behaviours, for example, via food availability in schools and in neighbourhoods (Navalpotro et al., 2012; Shier et al., 2012; Tester, Yen, & Laraia, 2010). The hypothesis linking the food environment to childhood obesity assumes that the increasing popularity of convenience stores and fast food restaurants has increased the proportion of meals consumed away from home and results in unhealthy dietary intake (Sallis & Glanz, 2006). Convenience foods and restaurant meals are typically higher in calories and fat and lower in valuable nutrients than meals prepared at home. In addition, a lack of access to and the high cost of fruits, vegetables, and other nutritious foods may keep children from consuming them. Research has generally focused on differences in food environments based on socioeconomic and demographic factors, such as research on food deserts, or on associations between food environments and diet-related outcomes, including eating behaviours, food purchasing and weight status. As broadly defined in the literature, 'food deserts' are geographical areas where access to healthy and affordable food is limited, and often characterized by the absence of large supermarkets and the presence of a greater number of fast food restaurants and/or convenience stores, especially in socioeconomically distressed neighbourhoods (Lucan, Barg, & Long, 2010; Malabar & Grant, 2010). Supermarkets, compared to other store types, tend to offer the greatest

variety of high-quality, nutrition dense products at the lowest cost, whereas fast food restaurants and convenience stores predominantly sell high-calorie food and few fresh products (Caspi et al., 2012). Children and families at greatest risk of obesity in low income or ethnic minority neighbourhoods appear to be more often exposed to relatively poor food environments, typified by greater concentrations of fast food outlets and convenience stores alongside limited access to large grocery stores (Bodor et al., 2010; Larson, Story, & Nelson, 2009).

The presence of different types of food outlets has been investigated for associations with children's weight status, but findings are less consistent. For example, studies among preschool children have found no associations between being overweight or obesity and access to food stores (Burdette & Whitaker, 2004). Yet in older children, an increased distance between home and the nearest supermarket has been associated with an increased risk for overweight (Powell, Wada, Krauss, & Wang, 2012; Story et al., 2007). Living within close proximity to fast food restaurants (Minaker et al., 2013), or going to a school in close proximity to fast food restaurants (Park, Choi, Wang, Colantuoni, & Gittelsohn, 2013) is associated within unhealthy weight outcomes; conversely, proximity to fast food restaurants or takeout outlets has been found to be unrelated to obesity and body mass index (Jeffery et al., 2006; Cox et al., 2005).

Neighbourhood-level Socioeconomic Variables

Although obesity is now a national and international public health concern, recent reports suggest that children and adolescents who live in multiethnic, low income, or inner-city neighbourhoods are at particularly high risk for obesity (Kipke et al., 2007; Oliver & Hayes, 2005; O'Loughlin, Paradis, Meshefedjian, & Gray-Donald, 2000). A

recent study, sampling children aged 10 to 17 across the US, described socioeconomic differences in obesity rates and found a strong association with adolescent obesity in household income below the poverty level (Paeratakul et al., 2002). There has also been an association found between family income and childhood obesity has been shown by ethnicity. For instance, Freedman et al. (2007) found income was positively associated with BMI in African American children and negatively associated with BMI in white children. A cross-sectional study in Canada (Oliver & Hayes, 2005) demonstrated that the prevalence of child and youth overweight is inversely and statistically significantly related to neighbourhood socioeconomic status, which was assessed using three census variables (unemployment rate, median family income, and population over 20 without post-secondary education). Canadian studies also have shown that children living in rural areas are more likely to be overweight than urban residents (Veugelers & Fitzgerald, 2005). Aboriginal Canadians have been recognized as having the highest prevalence of obesity and are among the most socioeconomically disadvantaged groups compared to other ethnic groups in Canada (Corey, Ng, & Young, 2011). According to an ecological perspective, characteristics within various settings, such as the home, school, and neighbourhood, can either encourage or discourage healthy eating and physical activity (Davison & Birch, 2001). To examine potential reasons for socioeconomic differences in risk of childhood obesity, a growing body of literature has focused on factors related to environmental inequality. For example, limited access to parks and recreational facilities in socioeconomically disadvantaged neighbourhoods may hinder children from being physically active and increases their risk of becoming overweight (Veugelers et al., 2008; Cohen et al., 2007).

Inequalities also exist in food environments across neighbourhoods, and these may contribute to inequalities in dietary quality. The literature examining associations between neighbourhood food environments and socioeconomic indicators, such as income, race, or ethnicity, is growing and has identified unsupportive local food environments in socially deprived geographical areas (Cerin et al., 2011; Gustafson, Hankins, & Jilcott, 2012; Smoyer-Tomic, Spence, & Amrhein, 2006). Specifically, these studies have concluded that fast food restaurants are more prevalent in low income areas compared with higher income counterparts. For example, research in Edmonton, Canada, has found greater fast food exposure and a lack of large grocery stores in neighborhoods with greater percentages of unemployed, low income, and renting populations (Hemphill, Raine, Spence, & Smoyer-Tomic, 2008). Studies in Scotland and England have found that the greater the neighbourhood-level deprivation, the more likely that residents were exposed to fast food restaurants (Smith et al., 2010). One recent study in Sao Paulo (Duran, Diez Roux, Latorre, & Jaime, 2013) found more full-service restaurants in higher education neighbourhoods and more fast food restaurants in neighbourhoods with lower education levels.

The health status of ethnic minority groups has been reported to be lower in comparison with Caucasians, and many disparities exist for preventable conditions like obesity (Williams et al., 2012). Most studies in the United States have found fast food restaurants are more prevalent in areas with higher concentrations of ethnic minority groups (Block et al., 2004; Dean & Sharkey, 2011). Similarly, a study conducted in three different areas in the United States has reported that non-Caucasian communities have fewer fruit and vegetable markets (Moore & Diez Roux, 2006). However, Morland and

colleagues (2002) found fast food restaurants were twice as common in white and racially mixed neighbourhoods; although the same study showed that fewer households in black neighbourhoods had access to private transportation and suggested that residents of these neighbourhoods had greater difficulty obtaining healthy food. In Canada, similar evidence shows that Aboriginal populations are facing very high rates of childhood obesity (Ferris, 2011). Many Aboriginal communities also have food environments typified by energy-dense foods of low nutritional value (Ferris, 2011). For example, Smoyer-Tomic and colleagues (2006) found more fast food outlets in neighbourhoods with a higher proportion of Aboriginal residents. As Aboriginal people in Canada have undergone the 'nutrition transition' by increasing the proportion of their diet from fast food or store-bought foods, Aboriginal children have been affected by obesity and its complications (Ferris, 2011). Several food environment studies have identified that lower income, lower education levels and lower literacy levels are likely major underlying causes of health disparities between Aboriginal and non-Aboriginal populations (Frohlich, Ross & Richmond, 2005; Downs et al., 2009). In Saskatoon, as a city with a large Aboriginal population, neighbourhoods with large Aboriginal populations have also been found to have lower incomes, lower educational attainment by residents and higher unemployment rates (Anderson, 2010).

Community Food Environment

According to Glanz et al. (2005), the food environment includes features of the distribution of food outlets in communities (that is, the *community food environment*), such as the number, type, and location of food outlets, otherwise described as the accessibility of food sources in the context of residential of neighbourhoods. Food outlets

refer to food stores (i.e., supermarkets, grocery stores, and convenience stores) and restaurants (i.e., full-service and fast food restaurants) (Ding et al., 2012; Glanz et al., 2005; Story et al., 2007). Most studies use GIS techniques to determine the geographic location of food outlets to capture the accessibility of the community food environment, frequently using proximity (the distance between a food outlet and another location) or density (the number of food outlets in a defined area) measures by types of food outlets (Holsten, 2009).

Several studies have examined how the community food environment is related to food purchasing, dietary behaviours and, ultimately, health outcomes among residents of a neighbourhood (Innes-Hughes, Boylan, King, & Lobb, 2012; Papas et al., 2007; Pereira, Sidebottom, Boucher, Lindberg, & Werner, 2014). There is consensus across the literature reviewing the community food environment that the health status of residents is likely to be influenced, at least in part, by the accessibility to different types of food stores and restaurants at the neighbourhood-level that promote or compete with sales of healthy food (Black et al., 2014; Engler-Stringer et al., 2014; Gustafson et al., 2012). In general, better access to grocery stores and supermarkets is associated with lower risk of obesity, while access to convenience stores and fast food restaurants is associated with increased rates of overweight or obesity (Story et al., 2007). Specifically, supermarket availability has been shown to affect both dietary quality and weight status measured by BMI (Moore & Diez Roux, 2006).

Recent discussions regarding the childhood obesity epidemic have also focused on how the differences in access to food may have important influences on children's dietary intake. Studies among children and adolescents have examined the association

between neighbourhood food accessibility and intake of fruits and vegetables, calories from dietary fat, and overall diet quality (Cerin et al., 2011; Downs et al., 2009). Most results suggest that children living in neighbourhoods with better access to supermarkets or other healthy food sources tend to have healthier food intakes (Engler-Stringer et al., 2014). But Skidmore and colleagues (2010) found density of supermarkets was associated with both an increased intake of vegetable and unhealthy foods. Greater proximity and density of fast food restaurants near middle and high schools is associated with a greater likelihood of students consuming fewer fruit or vegetables and more servings of soda (Davis & Carpenter, 2009), but there was no relationship found between food outlet density from children's homes and their dietary consumption (An et al., 2012).

Consumer Food Environment

The consumer food environment reflects what consumers encounter within or around a retail food outlet (i.e., store or restaurant), including features such as the availability and affordability of food options, the nutritional quality of food available, within-outlet promotions, and point-of-purchase nutritional information (Glanz et al., 2005; Saelens et al., 2007). There have been fewer studies examining consumer food environments compared to community food environments and the findings of these studies are mixed. Most studies use in-store audit by using observational tool to measure consumer food environments and to determine whether greater availability and quality of foods or lower price for healthy food is associated with healthier dietary outcomes. For instance, Sturm and Datar (2011) found lower prices of fruit and vegetable predicted high intake frequency. However, a recent literature review (Black et al., 2014) summarizes that most studies investigating consumer food environment and diet revealed no robust

relationship between the availability of healthy products and dietary outcomes, and almost half of findings showed that higher prices of healthy foods increased consumption of these.

Although healthy and unhealthy food purchases can be made almost anywhere, the distinctions between the types and concentrations of food stores or restaurants in neighbourhoods are important because they may be a proxy for quality, cost, and exposure (Lee, 2012). Conveniences stores or small grocery stores are considered less healthy food outlets because a greater proportion of the foods sold in these outlets are snack or junk foods, compared to large grocery stores where there are more fresh produce, whole grains, and low-fat dairy items (Jetter & Cassady, 2006). Moreover, food prices tend to be higher in smaller grocery stores than in supermarkets. Research also examines the consumer's experience within restaurant environments, which differ in different restaurant types, such as those that contribute most to fat and calories (i.e., fried potatoes and sweetened drinks), or those that are most recommended for healthy eating and are consistent with dietary guidelines (i.e., fresh fruits and vegetables). Meals in chain fast food restaurants are considerably greater in caloric content, fat, and portion size than those served in sit-down restaurants or prepared at home (Story et al., 2007). There is evidence that children who report eating fast food consume on average 150 more calories a day than children who do not eat fast food (Van Hulst et al., 2012).

Although different tools have been used across the studies, the assessment of the consumer food environment and its potential impact on eating outcomes are still challenging, partially because determinants of eating behaviours are complex and influenced by not only the availability of food and beverages in stores or restaurants but

also their dietary intentions (Batada et al., 2012; Beydoun, Powell, Chen, & Wang, 2011; Bleich & Pollack, 2010). For instance, marketing strategies, such as pricing, promotions, signage, and how the menu is designed, could impact consumers' food choices (Cohen et al., 2012; Lesser et al., 2013). Empirical studies have shown repeatedly that large portion sizes increase food intake and are thereby a risk factor for obesity (Burger, Cornier, & Ingebrigtsen, 2011; Mattes, 2013). As a result of marketing strategies, such as lowering the price per unit for large portions compared to small portions, consumers are stimulated to select a large portion (Heymans, Leeuwis, Seidell, Steenhuis, & Vermeer, 2011). Freedman and colleagues (2010) demonstrate that reducing portion size of a particular item in an all-you-can-eat environment results in reduced intake of that food for most individuals. A recent study also demonstrates that the number of calories purchased was lower 18 months after implementation of menu labeling, such as nutrition information and calorie counts, in some chain restaurants, although the long-term impact of nutrition labeling on customer choices is unknown (Krieger et al., 2013; Saelens et al., 2012).

Food Environments in Restaurants

Over the last decades, food eaten in restaurants has become a much larger part of the North American diet (Cummins & Macintyre, 2006). When people dine away from home, however, the meals they consume are generally nutritionally inferior to what they would consume otherwise (Krukowski, Eddings, & Smith West, 2011; Longacre et al., 2012; Reedy, Krebs-Smith, & Bosire, 2010). There is evidence, for example, that meals in restaurants, especially fast food restaurants, tend to be calorie-dense and of poorer nutritional quality than foods and beverages consumed at home (Hearst et al., 2013), and thus consuming these may result in greater weight gain. Frequency of eating in

restaurants is positively related to increases in childhood weight and obesity rates, perhaps due to many unhealthy choices available in restaurants and resultant higher energy consumption (Brownson et al., 2009). Fast food restaurants, in particular, have been identified as a potential contributor to higher childhood obesity prevalence (Block et al., 2004). A number of studies have shown that older children who consume greater quantities of fast food are heavier and have greater total energy intakes (Hearst et al., 2013; Lucan et al., 2010; Poti, Duffey, & Popkin, 2014). Similarly, there is longitudinal evidence that greater fast food consumption is associated with increased weight gain from childhood to adulthood (Fraser, Clarke, Cade, & Edwards, 2012; Mandal & Powell, 2014).

Some research has found that different restaurant types may be concentrated in neighbourhoods according to their socioeconomic characteristics (Duran et al., 2013). Fast food outlets target children and adolescents in their advertising, and select restaurant locations that are accessible and proximate to their target demographic (Austin et al., 2005). For example, one nationally representative study in the United States (Powell et al., 2012) has shown that, compared to high income areas, lower income areas and predominantly black areas were found to have a higher proportion of fast food restaurants compared to other restaurant types. In addition, a number of studies have also found that restaurants in affluent neighbourhoods provide a greater number of healthy menu options compared to restaurants located in more deprived neighbourhoods (Black, Moon, & Baird, 2014; Meyer et al., 2014).

In addition to the research regarding inequalities in accessibility across residential neighbourhoods, studies have examined how to encourage children and their parents to

choose healthy restaurant meals (Beydoun et al., 2011; Bleich & Pollack, 2010). Studies in children have documented that restaurant food price is related to dietary intake. Lower fast food prices, for example, have been correlated with poorer diets (Keller et al., 2012). Other studies provide evidence in support of claims that menu labeling may improve the healthfulness of restaurant meals or at least customer awareness of healthy food choices (Longacre et al., 2012; Saelens et al., 2012). However, some intervention studies on food consumption among adolescents have found that caloric or nutrition information is not a major consideration in food choices, while taste, cost, peer preferences or other factors appear to be more important (Brissette, Lowenfels, Noble, & Spicer, 2013; Dunn, Mohr, Wilson, & Wittert, 2011; Keller et al., 2012). One recent study in low income communities in New York City, examining children's fast food choices and the influence of calorie labels in restaurants, found no evidence that labeling influenced adolescent food choice or parental food choices for children (Elbel, Gyamfi, & Kersh, 2011). On the other hand, a significant association exists between children's food preferences (healthy or otherwise) in restaurants and parents' reported food and beverage purchases, suggesting parent role modeling (Ferguson, Muñoz, & Medrano, 2012; McIntosh et al., 2011), although the impact of parents on the food choices of their children has not been fully examined.

Food Environment Measurement

Dimensions of Food Environment Measures

Studies exploring relationships between food environments, dietary habits, and obesity have used a wide variety of methodologies to measure the degree of exposure to healthy or unhealthy food for study participants. Most of the literature focuses on the

methods of exposure assessment, such as GIS, survey, and store audits (Caspi et al., 2012). According to Glanz and colleagues' conceptual model (2005), food environment measures are frequently divided into those that measure community food environments, which mainly reflect the accessibility of food service outlets (Charreire et al., 2010; Glanz et al., 2005), and those that measure consumer food environments, such as the availability, diversity, and nutritional quality of food within outlets (Glanz et al., 2005; Gustafson et al., 2012). Accessibility in the literature most often refers to geographic exposure, such as the number or the location of food outlets, and ease of getting to that location. Distance and travel time are primary measures of accessibility. However, measures representing food accessibility demonstrate inconsistent associations with dietary outcomes. For instance, Timperio et al (2008) found that the farther the distance children live from a supermarket or a fast food outlet, the greater their vegetable consumption; while Jago et al (2007) found that travel time to the nearest small food store, but not large food store, was a positive predictor of fruit and vegetable consumption. Availability, in a consumer food environment, refers to an adequate supply of certain food categories, such as the presence of healthy food items in restaurants near people's homes. Other measures that have been used include food prices or perceptions of the cost (affordability), and people's attitudes toward their local food environments (acceptability) (Caspi et al., 2012). A handful of studies, based on store audit methods, have assessed the product availability and variety generally and have shown positive relationships with healthier diets (Cash, Minaker, & Raine, 2009; McKinnon, Reedy, Morrissette, Lytle, & Yaroch, 2009; Timperio et al., 2008).

Measurement

Good measurement is essential for capturing different aspects of the food environment and variations across these, such as socioeconomic and racial disparities (Glanz et al., 2005; Lytle, 2009; Morland & Evenson, 2009). Community food environment data are available from various sources: GIS-based analyses of land use data, census data, public health or agriculture department food license lists, telephone books, websites, as well as commercial sources (Story et al., 2007). Each method has advantages and limitations, and a combination of sources is suggested (Glanz et al., 2005; Glanz et al., 2007; Saelens et al., 2007). Different measurements have been developed for characterizing consumer food environments (Lytle, 2009). Baker and colleagues (2006) developed a measurement instrument to assess the ability of supermarket and fast food restaurants to provide food that meets dietary guidelines. Latham and Moffet (2007) comprehensively described a consumer food environment by conducting interviews with storeowners and recording availability and cost of a standard inventory of food items in Canada. The Nutrition Environment Measure Survey for Stores (NEMS-S) (Glanz et al., 2007) and Nutrition Environment Measure Survey for Restaurants (NEMS-R) (Saelens et al., 2007) are observational tools that primarily measure the consumer food environment. Specifically, NEMS-S was developed as a tool to assess the availability of healthful options, prices, and quality within grocery stores and NEMS-R was developed to evaluate the healthfulness of options in restaurants. High reliability and validity are reported for both instruments (Glanz et al., 2007; Saelens et al., 2007).

Although the type of food stores or restaurants is usually employed in the existing literature as a proxy for healthy choices, there is evidence to show that healthy food availability varies in different food outlets of the same broad category (such as the

differences between burger and sandwich fast food restaurants), and these also can differ depending on the characteristics of the neighbourhood where they are located (Duran et al., 2013). Therefore, combining both community and consumer food environment measures allows a more comprehensive examination of food environments. For example, measures should integrate geographic analysis, and compare the proximity, density, and diversity of food outlets, with the healthfulness of the food available within outlets, such as with menu analyses, checklists, inventories, and questionnaires within different geographically defined areas (Engler-Stringer et al., 2014; McKinnon et al., 2009).

Geographic Information Systems (GIS)

Various exposure measures have contributed to the assessment of the community food environment (Charreire et al., 2010; Larsen & Gilliland, 2008; Smoyer-Tomic et al., 2006). Among them, measures based on GIS techniques are most frequently used to assess food environment exposure and its relationship with dietary behaviours. GIS are computer-based methods and tools, which enable spatial data to be organized, combined and managed via different information sources, and results to be presented and analyzed according to geographic locations (Longley, 2000). The majority of data in public health has a spatial component (location), to which GIS adds a graphical and analytic dimension by combining the individual, time, and place (Wade et al., 2006). In most health literature, two common GIS-based measures are used to characterize access as a characteristic of food environments, the first focused on density and the second on proximity. Density measures calculate the number of food outlets (i.e., food stores and/or restaurants) in a geographically defined area (i.e., census blocks or postal units) or in an area otherwise defined by the authors of a particular study interest. Proximity measures

usually examine the distance between two locations, such as from a respondent's location (i.e., home or school) to the closest food outlets, measured by travel time or by distance.

Buffers define a zone around a given location within a shaped distance (Charreire et al., 2010). The location can be respondents' home or work address, school location, or the geometric centre of the neighbourhood (Gustafson et al., 2012). The buffer can be constructed either by a zone with a specific radius surrounding a location (circular buffer) or by a zone along the street network via the mode of transportation used (network buffer). A wide range of buffer distances have been used in previous studies, including circular buffers ranging from 100m for small food stores (Bodor et al., 2010) to 2500m for large markets (Jeffery et al., 2006), and network buffers ranging from a distance of 500m to 1000m by foot around a supermarket (Larsen & Gilliland, 2008). Instead of a buffer distance from a location, some studies examine access to food outlets within a census tract (Gustafson et al., 2012; Morland et al., 2002) or block group (Laraia, Siega-Riz, Kaufman, & Jones, 2004) as the geographic measure of interest. Notably, while some previous studies have used a circular buffer to identify all sites within a predetermined, straight-line distance from an origin, this technique does not take into consideration how people actually move in geographic space, and therefore network buffers are considered more robust than circular buffers (Larsen & Gilliland, 2008; Timperio et al., 2008). There are also several types of distances typically used to assess proximity with GIS, such as a straight-line distance between home/school to food outlets (Laraia et al., 2004), city block distance (Zenk & Powell, 2008), and network distance by road (Timperio et al., 2008; Zenk & Powell, 2008). Proximity has also been measured by travel time between a given home/school address and food outlets according to the means

of transport and the specificities of the network calculated by GIS (Burns and Inglis, 2007; Pearce et al., 2007).

Nutrition Environment Measures Survey for Restaurants (NEMS-R)

Although research on the environment within restaurants is limited, some recent developments have been made in the measurement of consumer food environments within restaurants. For example, Cassady et al. (2004) developed a reliable menu checklist for use by community members to assess cues for healthy choices in restaurants. However, it fails to assess the whole restaurant environment by only testing a small sample of 14 family-style restaurants. Developed from the conceptual model by Glanz, et al. (2005), the NEMS-R observational measure for restaurants (Saelens et al., 2007) was originally developed for use in the United States, and its measures are designed to assess dietary factors believed to contribute to food choices in restaurants, including availability of healthy foods and beverages, facilitators and barriers to healthful eating, pricing, and signage/promotion of healthy and unhealthy foods. The instrument can rate the consumer food environments of all types of restaurants, including sit-down, fast casual, and fast food restaurants. Other establishments, such as coffee shops, and cafeterias where lunch or dinner items are served, can also be rated. The data collection procedures include a menu review, a restaurant observation visit, and an interview with restaurant staff if needed. The NEMS-R scoring system gives most items on the scale between +3 and -3 points, based on their contribution to healthy eating. Measures, protocols, and a description of the development of NEMS-R have been reported. NEMS-R has shown high inter-rater and test-retest reliability, with most kappa values greater than 0.80 and all percent-agreement values greater than 75% (Saelens et al., 2007).

Specifically, NEMS-R assesses the availability of healthy regular and children's menu options (including healthy entrées, main-dish salads, fruits, vegetables, and beverages), facilitators (such as nutrition information provided on menus or at point of purchase) and barriers (for example, super-sizing portions encouraged) to healthy eating, and comparative pricing between healthy and unhealthy options and the quantity of food (more or less) (Honeycutt, et al., 2010; Saelens, et al., 2007). Criteria for designating menu items as 'healthy' are primarily based on calorie, and fat, contents and saturated fat composition compared to government recommended standards for a healthy diet (Cash et al., 2009; Minaker et al., 2013; Saelens et al., 2007). The facilitators of healthy eating measures assess the availability of nutrition information, whether healthy options are identified and promoted, and if there is the signage or other cues of encouragement to eat healthfully. Information about the nutritional content of the food is considered available if it can be found online or within the food outlet. In contrast, the barriers to healthy eating scale within the tool evaluate the presence of signage or other cues that encourage customers to overeat, to choose large portions, and to purchase unhealthy options.

Challenges

While aspects of the food environment have been measured by a great number of studies recently, many challenges remain (Caspi et al., 2012; McKinnon et al., 2009; Saelens & Glanz, 2009). For instance, few of the studies exploring the community food environment consider its interrelationship with cultural, social and economic factors, resulting in a large gap in the literature. It should be noted that spatial accessibility of healthy food is only one of the multiple determinants of healthy eating (Charreire et al., 2010); however, availability, diversity, and affordability of food outlets, as well as

subjects' perception of the food environment in their neighbourhoods, may also influence individuals' food behaviours. Moore et al. (2006) made recommendations that the availability of healthy food as reported by residents and its accessibility as measured by GIS may provide a complementary source of information for characterizing neighbourhood food environments. Two systematic reviews (Caspi et al., 2012; Engler-Stringer, Le, Gerrard, & Muhajarine, 2014) also have suggested it might be particularly important to focus future research on combining GIS-based measures with self-report measures of the community food environment, as well as measures of consumer food environment.

The increased use of GIS methods has resulted in various exposure assessment techniques (An & Sturm, 2012; McKinnon et al., 2009; Pabayo, Spence, Cutumisu, Casey, & Storey, 2012), but finding appropriate and consistent criteria for defining geographic boundaries has proven challenging (Charreire et al., 2010). For example, as noted by Morland et al (2006), the geographic boundaries that GIS imposes may not be relevant to study samples. Specifically, circular buffers, street network distances, and geographic administrative units (i.e., census tracts and ZIP codes) have been frequently used as proxies for defining neighbourhoods in food environment research. As a rough estimate of a resident's neighbourhood, however, it is not clear whether these neighbourhood boundaries are equally relevant when evaluating access to various types of food outlets in neighbourhoods across racial, ethnic, and socioeconomic groups (Hill et al., 2012; Wong, 1996). Another major challenge when using GIS for studying the food environment concerns the validity and the quality of available data sources. GIS-based analyses are usually derived from secondary source data that is not ground-faithful, and

such data may misrepresent true geographic accessibility, either through discrepancies between the geocoded location and the true location of a facility (Boone et al., 2008), or through failing to accurately represent the most up to date openings and closings of food establishments, thereby incorrectly including food outlets that are no longer in business and/or failing to include recently opened outlets (Liese et al., 2010).

NEMS-R is limited as a validated measurement of the healthfulness of foods and beverages in restaurants for the following reasons. First, the assessment focuses on series of nutritional indicators in restaurants, such as availability of healthy items, promotion/signage for healthy eating, and barriers to healthful eating. These indicators of the instrument were designed to evaluate selected attributes that could be readily observed, as well as relevant to eating behaviours. However, there are likely to be other restaurant environment factors of interest to researchers that are not part of NEMS-R (Horacek, 2013; Saelens et al., 2007). For example, the general NEMS-R protocol counts items marked or highlighted as healthful on the main menu, and thus more specific nutrition information for menu items is considered preferable to improve the level of healthfulness during assessments. But not all restaurants use this way to disseminate health information, and as a result, many restaurants where such detailed information is generally lacking but still offering healthful food may get lower NEMS-R scores than they should because of the lack of nutrition information. Secondly, NEMS-R only assesses the relative healthfulness of foods and beverages available on the menus; it does not evaluate the actual healthfulness of foods, which would require laboratory or recipe analyses (Horacek, 2013; Saelens et al., 2007). Specifically, items in NEMS-R aim to evaluate whether healthier options are available, without considering what the most

healthful possible choice might be. Large portion size may contribute to consumers becoming overweight, for example, but the NEMS-R protocol is not designed to directly assess portion size, thus making the distinctions among restaurants that offer 'standard' portions of varying sizes vague (Saelens et al., 2012). In addition, NEMS-R can be useful for detailed nutrient-based analysis (Horacek, 2013), but it also generates extensive data to manage, and thus may be time consuming and labour intensive for data collection and analysis. There is evidence that the average time required for each restaurant site visit and menu evaluation is thirty minutes, not including travel time (Lytle, 2009). Although the measure is feasible, in that it requires little interaction with restaurant staff, and as such protects the business environment; the costs of implementation can be substantial compared to other in-store instruments (Lytle, 2009; Saelens et al., 2007).

Summary

This review found some evidence of the relationship between food environments and dietary behaviours in children, which play an important role in prevention of childhood overweight and obesity. Results from research also reveal that local food environments have come to the fore as a modifiable determinant of eating habits (Ball & McCargar, 2003; Caspi et al., 2012; Fleischhacker, Evenson, Rodriguez, & Ammerman, 2011; Osei-Assibey et al., 2012). Specifically, the accessibility and availability of fast food outlets in neighbourhoods has been directly correlated to children's food choices, and eating habits, and thus indirectly to their health status.

There is evidence for inequalities in food access in the US and the majority of research indicates that poorer accessibility and availability of healthy food are more likely to be found in low income or ethnic minority neighbourhoods; trends are less

evident in Canada and other countries. There is also evidence for wide variation in measures used to characterize food environments, and the application of GIS-based measures and NEMS-R helps to illustrate important relationships between geographic distributions, healthfulness of restaurant food environments and socioeconomic determinants. But there has been relatively little discussion specifically devoted to how local food environments could relate to neighbourhood socioeconomic characteristics using multi-dimensional measures and environmental exposures. As discussed throughout this review, Canadian-specific research is currently limited and further research exploring the impact of the food environment on children's health is needed. In order to fill some existing knowledge gaps in Canadian food environment research, this study characterizes restaurant food environments in Saskatoon by neighbourhood socioeconomic characteristics to understand their potential impact on children's eating behaviours.

CHAPTER 3
METHODS

Study Design

The current study comprises a part of a larger research project entitled 'Characterizing the Food Environment in Saskatoon for Families with Children', also known as *Smart Cities, Healthy Kids: Food Environment*. The project aims to examine food environments in Saskatoon neighbourhoods, with a focus on children's health, using Geographic Information Systems (GIS), Nutrition Environment Measures Survey for Stores and Restaurants (NEMS-S and NEMS-R, respectively), individual-level measures of weight, height, and diet, as well as in-depth interviews and photo-voice. This portion of the larger study includes a quantitative research design to specifically characterize restaurant food environments for families with children living in Saskatoon neighbourhoods. The study uses network-based GIS accessibility measures and a structured observational tool (NEMS-R) to characterize the Saskatoon's restaurant community and consumer food environments. Using the City of Saskatoon's Neighbourhood Profiles (developed using data from Statistics Canada), this study also examines the differences in restaurant food environments as a whole, and more specifically fast food environments for children living in residential neighbourhoods characterized by their socioeconomic characteristics.

Setting and Sample

This study sample includes all sit-down restaurants, fast food restaurants, and coffee shops in the city of Saskatoon as of March 2011. Building on the previous food access mapping work and research in Saskatoon conducted by Public Health Services, Saskatoon Health Region (Kershaw et al., 2010), the larger project (*Smart Cities, Healthy Kids: Food Environment*) obtained a database inventory from the City of Saskatoon to map all food stores and restaurants located in Saskatoon neighbourhoods. During the NEMS-R data collection in February and March of 2011, research assistants conducted restaurant site visits to all restaurants in the city and identified some restaurants that had closed and removed them from the list, and added some newly opened restaurants. Therefore the final sample, which reflects only the restaurants open during the above two mentioned months of data collection, is comprised of a total of 455 restaurants across 70 Saskatoon neighbourhoods. Among these, restaurants (n=111) located in non-residential neighbourhoods, though measured as part of the study, were excluded from the analysis.

To provide a more nuanced analysis of the potential role of different restaurant types in the food environment of children, I provided a more detailed classification of the restaurants in our sample by dividing them into nine categories adapted from Saelens et al (2007). As Figure 3-1 shows, the categories developed are: regular sit-down restaurants (for example, Tomas Cook Family Restaurant and Smitty's Family Restaurant), high-end sit-down restaurants (for example, Carver's Steakhouse and Calories Restaurant), cafeteria sit-down restaurants (for example, Fuddruckers), chain coffee shops (such as Tim Horton's and Robin's Donuts), independent coffee shops, burger and chicken (such as McDonald's, KFC, and Dairy Queen), pita and sandwich (such as Extreme Pita and Subway), pizza (for example, Vern's Pizza and Pizza Hut), and ethnic (for example, Edo

Japan and Taco Time) fast food restaurants (see Appendix B for numbers of detailed restaurant categories in each residential neighbourhood).

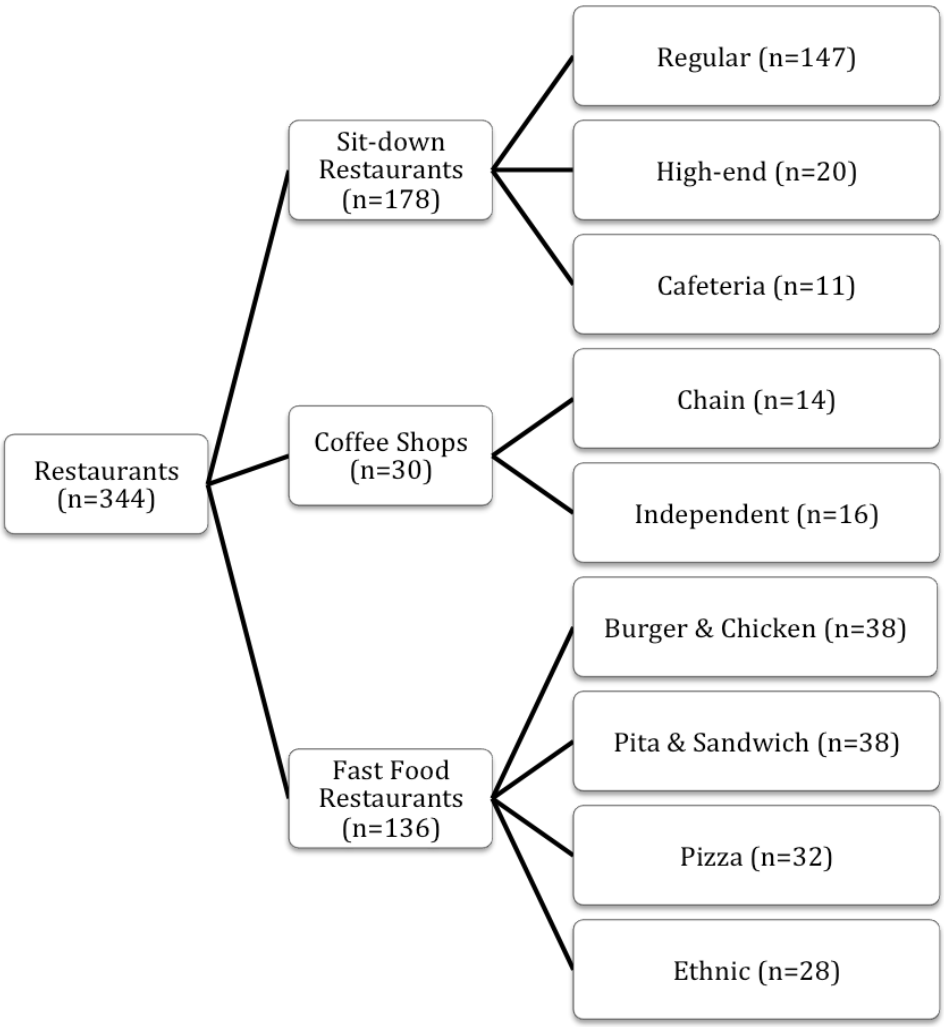


Figure 3-1. Categories of restaurants in residential neighbourhoods

Assessing Neighbourhood Socioeconomic Status

The City of Saskatoon Community Services Department uses neighbourhoods to describe Saskatoon communities. A standard neighbourhood is a comprehensively planned unit and meant to be serviced and maintained in an efficient manner over the long term. Saskatoon's neighbourhood boundaries are geographically defined by local understanding with respect to "natural boundaries", including major streets, railways,

water bodies or wetlands. Geographic boundaries and socioeconomic data for neighbourhoods were obtained from the City of Saskatoon, which receives custom Statistics Canada data based on Saskatoon neighbourhood boundaries.

Studies examining the differences between food environments in neighbourhoods have found that residents of more socioeconomically distressed areas often have less access to healthy food compared with residents of more affluent areas, which may result in less healthy diets. In order to test hypotheses regarding neighbourhood socioeconomic characteristics and restaurant food environments, I determined an area-based distress index to rank neighbourhoods that uses indicators of relative socioeconomic characteristics, including income, employment, and education. These specific indicators came from the dimensions of the Material Deprivation Index (which expresses the lack of goods and amenities), a tool developed by the Institut national de santé publique du Québec (INSPQ) (Pampalon et al., 2009) and used to characterize neighbourhood distress level (Cushon, Creighton, Kershaw, Marko, & Markham, 2013; Lebel, Pampalon, & Villeneuve, 2006).

Using data from the City of Saskatoon Neighbourhood Profile (8th edition, 2007) that use Statistics Canada Census and projected data from the City of Saskatoon's 2006 census (obtained from Community View Collaboration, www.communityview.ca), neighbourhood characteristics variables were specifically derived for low income (defined as proportion of economic families or persons not in economic families, falling below the low income after tax cut-offs), low educational attainment (defined as proportion of individuals 15 years and older with no certificate, diploma, or degree), and unemployment (defined as proportion of unemployed individuals aged 15 or over).

Following the methods used by Larsen and Gilliland (2008), this study incorporated these variables into one composite index to highlight the neighbourhood distress level with multiple indicators. Z-scores were calculated for each variable (based upon the mean and standard deviation of each indicator), and summed into a total distress index for each residential neighbourhood and then classified into tertiles (that is, low, mid, and high distress levels) for comparison and analyses. The socioeconomic variables used to characterize neighbourhood distress level and the resulting neighbourhood rankings can be found in Appendix C.

Assessing the Restaurant Community Food Environment

The community food environment in restaurants was mainly measured by distributions of restaurants by different categories within neighbourhoods. GIS-based techniques were used to characterize the geographic distribution of restaurants across residential neighbourhoods in Saskatoon. Specifically, as part of the larger study, a database inventory of all types of restaurants across Saskatoon's neighbourhoods as of March 2011 was developed. Then the locations of restaurants on the list were geocoded in this study to present their geographic distribution along with neighbourhood distress levels. The number of each type of restaurant, which measures the proportional distribution, was calculated in each neighbourhood, and summed by neighbourhood distress level to examine the differences in restaurant distribution.

Assessing the Restaurant Consumer Food Environment

The Nutrition Environment Measures Survey for Restaurants (NEMS-R) was used for evaluation of the consumer food environment in restaurants. The procedures for

completing ratings of restaurants in the city were conducted by trained research assistants during February and March 2011 after online and two-day in-person training in the administration of NEMS-R. Following the standard protocols of NEMS-R (Saelens et al., 2007), trained raters visited each restaurant to confirm restaurant type designation, conduct a site visit, and collect a take-away menu to administer the NEMS-R. If no paper menu was available, raters completed observations onsite based on posted menu boards. In addition, Internet information was also obtained for restaurants with websites.

Based on the information collected from restaurants, the instrument measures the healthfulness of foods and beverages available on the main and children's menus, with a focus on availability of healthy entrées, side dishes, and beverages, and facilitators or supports encouraging healthy eating, barriers discouraging healthful eating, as well as relative pricing for healthy and less healthy choices (see Table 3-1 for detailed NEMS-R item content). Assessment of children's menus as part of the data collected was omitted because children's menus were only available in a small number of restaurants (39.2%) in the city, and there is little evidence about the impact of children's menus on their dietary intake (Krukowski, Eddings, & Smith West, 2011). Collection of NEMS-R data is followed by data cleaning and entry, composite score and sub-score development and in-depth analysis. The scoring procedures for NEMS-R (Saelens et al., 2007) involves positive scores for availability of healthful options, nutrition information and facilitators encouraging healthful eating, and negative scores for barriers to healthy eating, as well as extra costs for healthy food choices. Based on the survey results, a total restaurant food environment quality score (ranging from -27 to 63) is calculated by summing the sub-scores for each NEMS-R item assessed (sub-score ranges are described in Table 3-1). To

permit meaningful comparison, NEMS-R scores are generated for different restaurant categories and for restaurants located in neighbourhoods with different distress levels by summing each restaurant's sub-/total scores.

Table 3-1. Restaurant Nutrition Environment Measures Content and Score Range

Item Category	Item Content	Sub-score Range
Healthy Entrées	• Main dish/entrées • Main dish salad • Low-fat/fat-free salad dressing	0 to 9
Healthy Side Dishes	• Non-fried vegetables • No-added sugar fruit • Baked chips • Whole-grain bread	0 to 12
Healthy Beverages	• Low-fat, skim, or non-fat milk • 100% fruit juice • Diet soda	0 to 9
Facilitators	• Nutrition information on menu or healthy item labeling • Nutrition information at point of purchase • Signs encourage healthy eating • Menu notations that encourage healthy requests • Reduced-size portions offered on menu	0 to 30
Barriers	• Super-sizing, large sizes encouraged • Menus discourage special requests • All you can eat or unlimited trips • Signs encourage unhealthy eating • Signs/banners encourage overeating • Low carbohydrate promotion*	-18 to 0
Pricing	• Combo meal cheaper than	-9 to 3

	individual items • Healthy entrées cost more than regular ones • Charge for shared entrée • Smaller portion at reduced price	
Total NEMS-R scores		-27 to 63

* Low-carb promotion, which is not proven as healthy, is considered signage advertising unhealthy options (Saelens et al., 2007)

Assessing the Fast Food Environment for Children

The data for school-aged children (10-13 years) living in Saskatoon neighbourhoods were collected as part of the larger project, the *Smart Cities, Healthy Kids: Food Environment* study. In January 2012 the project contacted 79 schools located in 46 socioeconomically diverse neighbourhoods across Saskatoon in order to request students to participate in a self-administered in-class survey. The survey instrument included questions on socio-demographic characteristics and a food frequency questionnaire (FFQ) for dietary assessment. To evaluate the fast food environment for children living in Saskatoon neighbourhoods, this study used their reported home addresses from the survey results for geocoding within the road network.

The fast food environment for children was evaluated by geographic accessibility of fast food outlets from children's home locations, and by the healthfulness of these outlets as assessed by NEMS-R scores. The fast food outlets surrounding children's homes included all types of fast food restaurants (burger and chicken, pita and sandwich, pizza, and ethnic fast food restaurants) and chain coffee shops that are similar to fast food restaurants in offering high caloric foods and beverages (e.g. donuts, pastries) at a lower

price, and minimal table service (Saelens et al., 2007). The locations of outlets were geocoded using ArcGIS along with the children's home addresses.

Specifically, using network-based GIS techniques (Network Analyst), two separate measures of accessibility to fast food outlets were computed for each child's residential address: 1) the number of outlets within 500m and 750m network buffers of the home location; and 2) the shortest possible distance (in metres) by road network from a child's home location to the closest fast food outlet. The Network Analyst function of ArcMap (version 10.2, ESRI, Redlands, CA, 2010) was employed to create a 'service area' of 500m and 750m network buffer zones respectively (the distances were selected and compared based on consideration of reasonable walking distances for children) (Black & Day, 2012; Fitzpatrick, Fulfrost, & Howard, 2011) around the location of each child's home. The total number of fast food outlets available, and the mean NEMS-R scores of these outlets within the buffer zone were then calculated for each child, and summed by neighbourhood distress level. Similarly, using 'closest facility' analysis within Network Analyst, the mean distances to and the mean NEMS-R total scores of the closest fast food outlets from children's homes via road network in each neighbourhood distress level were generated, by calculating the distance from each child's home to the nearest outlets and its NEMS-R score. Instead of the straight-line (Euclidean) distance, I use network-based GIS measures – gauging the actual distance to travel by foot or vehicle to reach the outlet – to more accurately represent the accessibility of fast food from children's homes (Pearce, Blakely, Witten, & Bartie, 2007).

Data Analysis

Using ArcMap GIS software (version 10.2, ESRI, Redlands, CA, 2010), this study geo-located all restaurants in Saskatoon neighbourhoods, and calculated their geographic distribution by type and by neighbourhood distress level. The software was also used to compute the geographic accessibility of fast food outlets, which was measured by the number of, and distance to, fast food outlets within the walkable buffer zones of children's homes.

All statistical analyses were performed using the SPSS statistical software package version 19.0 for Windows (IBM Corp., 2010); for each inferential statistical test, a p-value <=0.05 was considered statistically significant. Descriptive characteristics – numbers of restaurant types, as well as means and standard deviations for total and sub-total NEMS-R scores – were used to describe restaurant food environments by neighbourhood distress level. The differences in the proportional distribution of each restaurant type were compared across neighbourhood distress levels using the Pearson Chi-square test for independence. Analysis of variances (ANOVA) with post-hoc Tukey's *B* tests was used to examine differences in mean NEMS-R scores for different restaurant types and for a given restaurant type in neighbourhoods of varying distress levels. The percentages of restaurants with healthy and unhealthy items as assessed by NEMS-R were calculated and compared by neighbourhood distress level. ANOVA was also used to investigate whether fast food environments for children varied by neighbourhood distress level by analyzing the following variables: 1) the mean number of fast food outlets within 500m and 750m buffer zones of children's homes; 2) distances via the road network from children's homes to the closest outlet; and 3) the mean NEMS-R scores for those accessible outlets.

CHAPTER 4
RESULTS

Distribution of Restaurants (Community Food Environment)

Geographic Distribution of Restaurants (Descriptive Maps)

The geographic distribution of various restaurant categories is presented on maps of Saskatoon's residential neighbourhoods (Figure 4-1 and 4-2). Composite z-scores (see Appendix C) were used to quantify the neighbourhoods into distress tertile levels, with higher distress level neighbourhoods mainly clustered in the areas west of the river and surrounding areas. Restaurants, as geocoded results display, were dispersed throughout Saskatoon neighbourhoods with a cluster apparent in the downtown area, and along major roads and intersections (Figure 4-1). Fast food outlets, especially, were clustered in the Central Business District and along Idywyld Drive North, 22nd Street West and 8th Street East, where surrounding neighbourhoods tended to be more distressed (Figure 4-2).

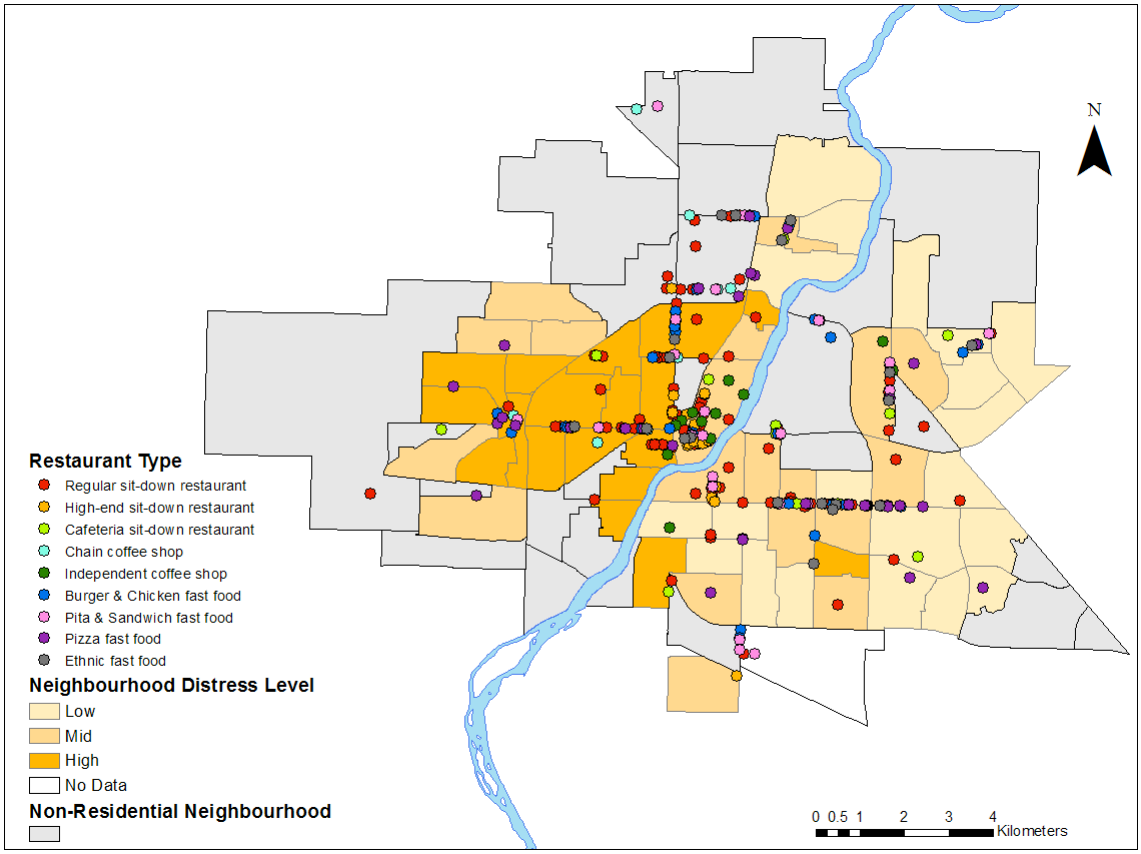


Figure 4-1. Distribution of all restaurant types in Saskatoon neighbourhoods

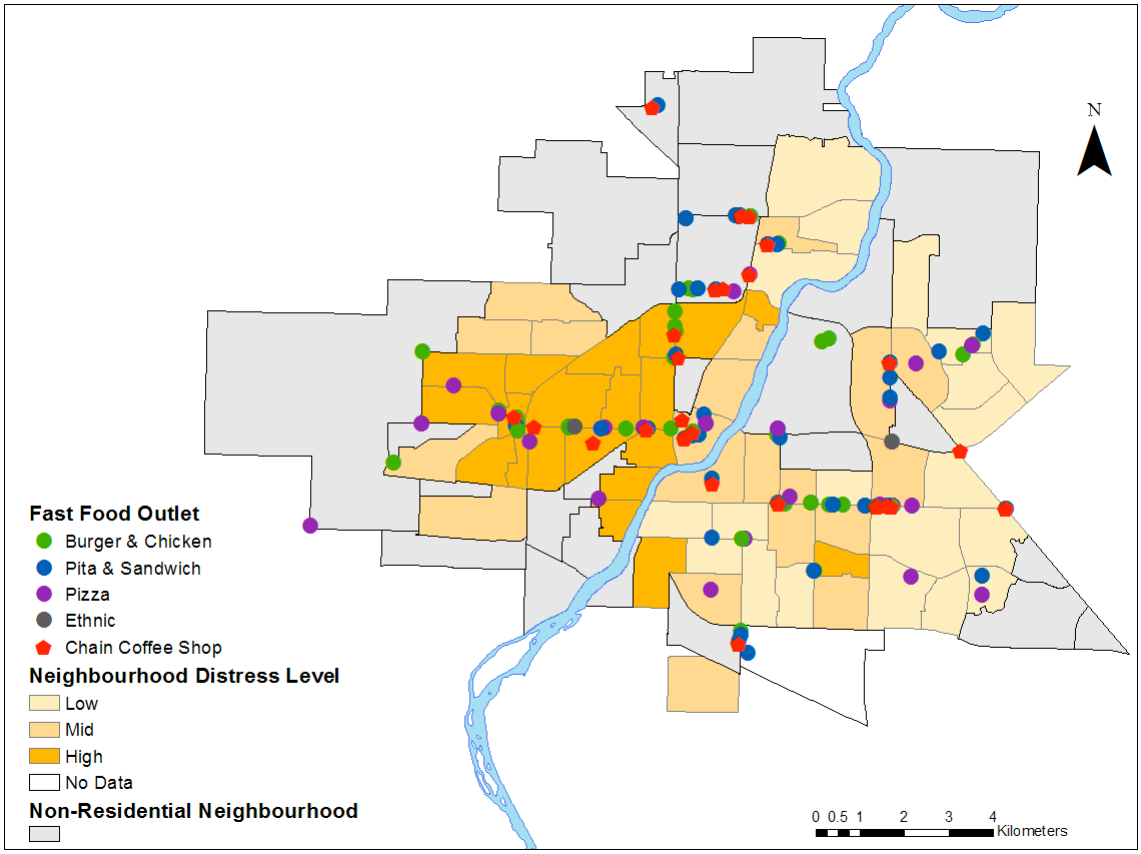


Figure 4-2. Distribution of fast food outlets in Saskatoon neighbourhoods

Proportional Distribution of Restaurants

There were a total of 344 restaurants, consisting of 178 sit-down restaurants (52%), 30 coffee shops (9%), and 136 fast food restaurants (39%) across 59 Saskatoon residential neighbourhoods (see Appendix B for the number of each restaurant type in each neighbourhood). Based on a detailed classification of restaurants (see Table 3-1), there were, in general, significant proportions of regular sit-down restaurants (n=147, 42.7%) and specific types of fast food restaurants, including burger and chicken (n=38, 11%) and pita and sandwich (n=38, 11%) restaurants, concentrated in residential neighbourhoods.

Table 4-1 illustrates the proportional distribution of each type of restaurant by neighbourhood distress level. In general, there are large numbers of restaurants located in neighbourhoods with a mid distress level (n=184, 53.5%), compared to low and high distress level neighbourhoods (n=60, 17.4%; n=100, 29.1%, respectively). To examine the differences in restaurant distributions by neighbourhood, a chi-square test was performed and a statistically significant relationship was found between restaurant types and neighbourhood distress levels, where χ^2 (16, N=344) =38.671, p= .001. For instance, almost all high-end restaurants (n=19, 10.3%) were located in mid distress level neighbourhoods, whereas neighbourhoods with a low distress level contained a smaller number of regular sit-down restaurants (n=17, 28.3%) but a larger proportion of pizza fast food restaurants (n=10, 16.7%).

Table 4-1. The number (percentage) of restaurant types by neighbourhood distress level

	Neighbourhood Distress Level		
	Low	Mid	High
Sit-down Restaurant			
Regular	17(28.3)	81(44.0)	49(49.0)
High-end	0(0)	19(10.3)	1(1.0)
Cafeteria	3(5.0)	4(2.2)	4(4.0)
Coffee Shop			
Chain	3(5.0)	5(2.7)	6(6.0)
Independent	2(3.3)	12(6.5)	2(2.0)
Fast Food Restaurant			
Burger &Chicken	10(16.7)	13(7.1)	15(15.0)
Pita &Sandwich	8(13.3)	23(12.5)	7(7.0)
Pizza	10(16.7)	12(6.5)	10(10.0)
Ethnic	7(11.7)	15(8.2)	6(6.0)
Total	60(100.0)	184(100.0)	100(100.0)

Healthfulness of Restaurants (Consumer Food Environment)

NEMS-R Scores by Restaurant Type

According to NEMS-R results, each restaurant was awarded a total score and constituent NEMS-R sub-scores, which were given for availability of healthful options (including healthy entrées, healthy side dishes, and healthy beverages), facilitators of healthy eating, barriers to healthy eating, and pricing of healthy and less healthy options.

Overall, the healthfulness in restaurants, assessed by NEMS-R scores, differed by restaurant categories. Firstly, I compared the NEMS-R scores for general restaurant categorization, which includes sit-down restaurants, coffee shops, and fast food restaurants. As table 4-2 shows, statistical analysis results show that the NEMS-R total score for sit-down restaurants (6.98) was significantly lower than that of coffee shops (13.37) and fast food restaurants (10.10). Compared to the other two types, sit-down restaurants rated poorer in offering Healthy Entrées (.46) and Facilitators (2.19) to encourage healthy eating. On the other hand, fast food restaurants had significantly lower scores in Barriers (-5.34) and Pricing (-2.12), which suggests that they discourage healthy eating more often compared to other types of restaurants.

Table 4-2. Comparison of NEMS-R scores by general restaurant categories

	Mean NEMS-R Scores (SD)				
	All	Sit-down Restaurant	Coffee Shop	Fast Food Restaurant	p-value*
Total	8.84 (10.193)	7.03 (7.727)[a]	13.40 (9.061)[b]	10.21 (12.539)[b]	**.001**
Healthy Entrées	1.00 (1.844)	.46 (1.311)[a]	1.30 (1.589)[b]	1.64 (2.256)[b]	**< .001**
Healthy Side Dishes	2.09 (2.615)	1.87 (2.488)	2.90 (2.784)	2.21 (2.714)	.111
Healthy Beverage	5.60 (1.743)	5.63 (1.677)	5.90 (1.470)	5.49 (1.882)	.485
Facilitators	4.97 (7.187)	2.19 (4.558)[a]	6.20 (8.028)[b]	8.33 (8.259)[b]	**< .001**

Barriers	-3.28 (3.425)	-2.01 (2.793) [a]	-1.50 (1.717)[a]	-5.34 (3.439)[b]	**< .001**
Pricing	-1.53 (1.847)	-1.10 (2.082) [a]	-1.40 (1.522) [a]	-2.12 (1.372)[b]	**< .001**

* ANOVA main effect significance level comparing NEMS-R scores by restaurant type
[a, b] Mean values within a row with unlike superscript letters were significantly different as determined by pairwise comparisons using Tukey's *B post hoc* test (P<0.05)

Secondly, as Table 4-3 shows, this study provides a nuanced breakdown of the data by comparing differences in NEMS-R scores by detailed restaurant categorization (see Table 3-1). The statistical analysis shows that there are significant differences in healthfulness by different restaurant types, as indicated by NEMS-R total and sub-scores (ANOVA tests, p< .001, except Healthy Beverages, p= .002). Specifically, chain coffee shops and pita and sandwich fast food restaurants had higher NEMS-R total scores (18.21 and 21.22, respectively), and Healthy Entrées sub-scores (2.50 and 3.55, respectively). Compared to pizza fast food restaurants (.56), pita and sandwich restaurants also had significantly more Healthy Side Dishes (5.31). Burger and chicken, pita and sandwich restaurants, and chain coffee shops rated more Facilitators of healthy eating (11.68, 12.42, and 12.29, respectively). However, more barriers (lower Barriers sub-scores) were found in burger and chicken (-7.58) and pizza (-5.81) fast food restaurants compared with independent coffee shops (.88) and high-end sit-down restaurants (.15).

Table 4-3. Comparison of NEMS-R scores by detailed restaurant categories

	Mean NEMS-R Scores (SD)						
	Total	Healthy Entrees	Healthy Side Dishes	Healthy Beverages	Facilitators	Barriers	Pricing
Sit-down Restaurant							
Regular	7.12 (8.295)[a]	.55 (1.425)[a]	1.78 (2.501)[b]	5.61 (1.657)[a]	2.57 (4.905)[a]	-2.20 (2.881)[b]	-1.16 (2.149)[a]
High-end	7.35 (3.483)[a]	.00 (.000)[a]	1.80 (2.042)[b]	6.00 (1.376)[a]	.15 (.671)[a]	- .60 (1.231)[a]	.00 (1.376)[a]

Cafeteria	5.18 (5.056)[a]	.09 (.302)[a]	3.27 (2.832)[b]	5.18 (2.359)[a]	.73 (1.679)[a]	-1.91 (3.081)[b]	-2.18 (1.401)[b]
Coffee Shop							
Chain	18.21 (9.932)[b]	2.50 (9.941)[b]	3.00 (2.882)[b]	6.00 (.000)[a]	12.29 (7.917)[b]	-2.79 (1.424)[b]	-2.79 (.802)[b]
Independent	9.19 (5.718)[a]	.25 (1.000)[a]	2.81 (2.786)[b]	5.81 (2.04)[a]	.88 (2.335)[a]	- .38 (1.025)[a]	- .19 (.750)[a]
Fast Food Restaurants							
Burger &Chicken	9.74 (9.540)[a]	1.37 (1.217)[a]	1.34 (1.665)[b]	5.61 (1.994)[a]	11.68 (5.836)[b]	-7.58 (2.176)[c]	-2.68 (.933)[b]
Pita &Sandwich	21.11 (13.026)[b]	3.55 (3.038)[b]	5.13 (2.407)[a]	6.08 (1.908)[a]	12.42 (10.464)[b]	-3.87 (3.112)[b]	-2.21 (1.339)[b]
Pizza	1.94 (9.722)[a]	.66 (1.335)[a]	.56 (1.190)[c]	4.31 (1.512)[b]	4.00 (6.059)[a]	-5.81 (3.316)[c]	-1.78 (1.497)[b]
Ethnic	5.54 (7.017)[a]	.54 (1.036)[a]	1.29 (2.507)[b]	5.89 (1.524)[a]	3.18 (3.611)[a]	-3.75 (3.708)[b]	-1.61 (1.524)[b]
p-value*	**< .001**	**< .001**	**< .001**	**.002**	**< .001**	**< .001**	**< .001**

* ANOVA main effect significance level comparing NEMS-R scores by restaurant type
[a, b, c] Mean values within a column with unlike superscript letters were significantly different as determined by pairwise comparisons using Tukey's *B post hoc* test (P<0.05)

NEMS-R Scores by Neighbourhood Distress Level

The mean NEMS-R scores for each residential neighbourhood are presented on the map below (see Figure 4-3) by summing the total scores of all restaurants in each neighbourhood. The larger the symbol, the higher the mean NEMS-R score is for the neighbourhood. However, there is no discernible pattern of neighbourhood distress level and mean NEMS-R scores from the map. For example, some high distress level neighbourhoods, geographically located west of the river, such as Richmond Heights, Mount Royal, Confederation Park, and Caswell Hill, are rated lower in NEMS-R scores (less than 3 points); while other neighbourhoods with a high distress level, such as Kelsey Woodlawn and Westmount, have higher mean NEMS-R scores (13.22 and11.67, respectively).

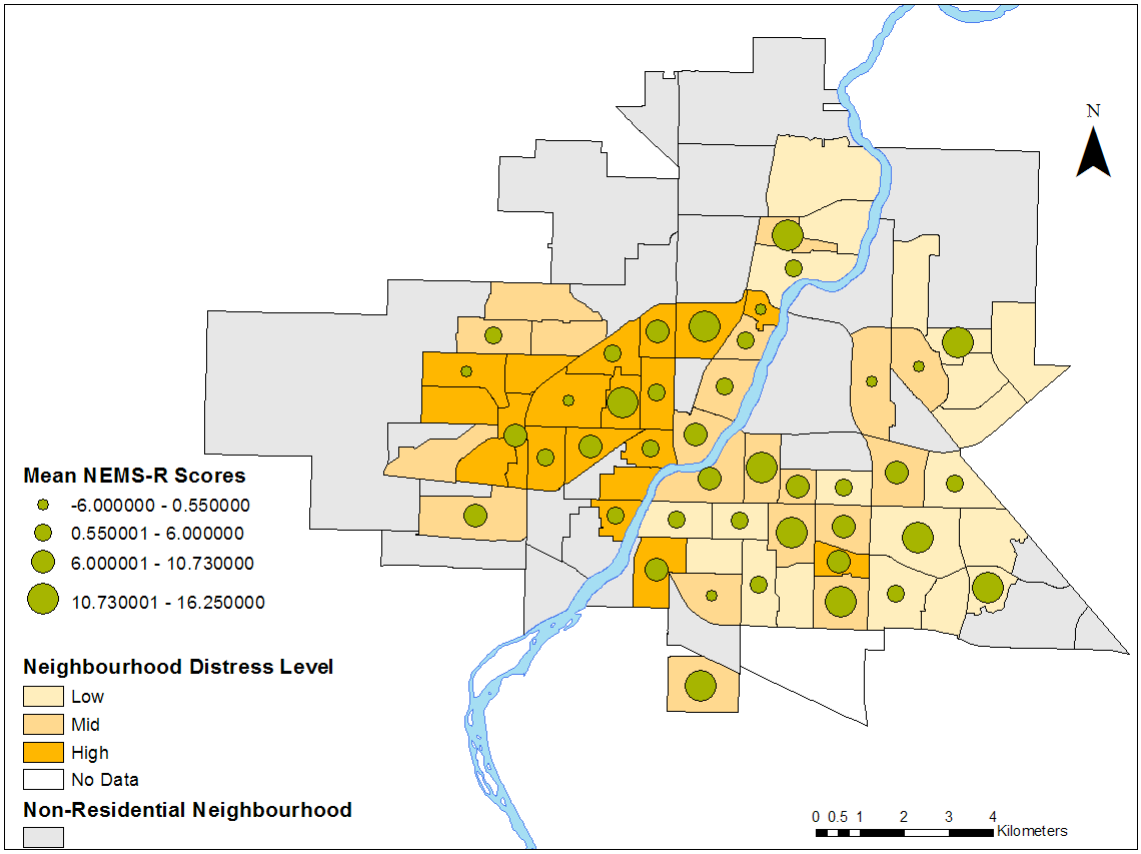


Figure 4-3. Mean NEMS-R scores in Saskatoon neighbourhoods

The study examines the restaurant consumer food environment, assessed by NEMS-R scores, by neighbourhood socioeconomic status characterized by distress level. The boxplot below (Figure 4-4) shows the distribution of NEMS-R total scores by neighbourhood distress level. The trend in the distribution of NEMS-R scores in each neighbourhood distress level is similar, mostly concentrated in the range of 2-15 points, with an exception of some restaurants scoring over the upper whiskers in mid and high distress level neighbourhoods. Median NEMS-R scores are also quite similar in each neighbourhood distress level, and slightly higher in neighbourhoods with a low distress level.

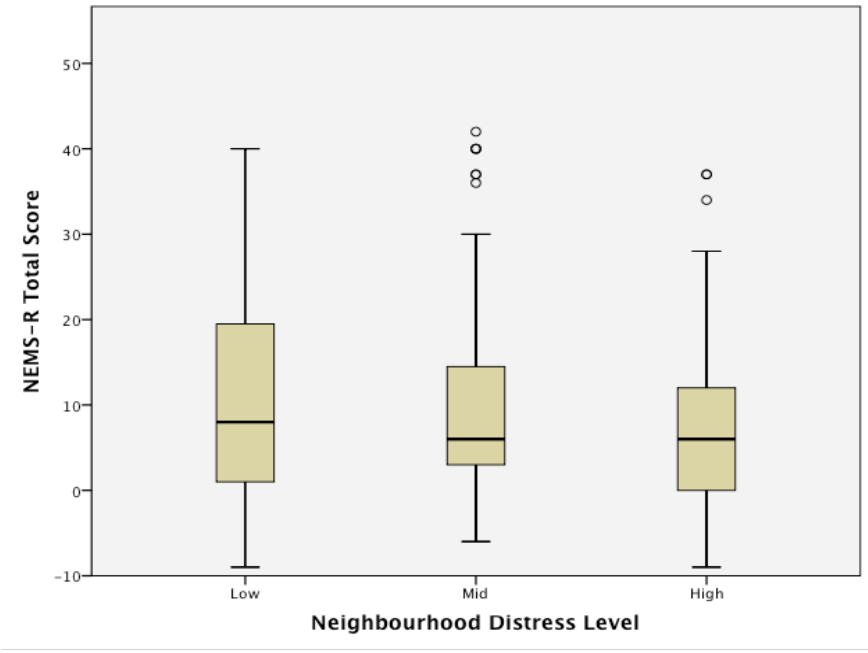


Figure 4-4. Distribution of NEMS-R scores by neighbourhood distress level

Table 4-4 compares constituent NEMS-R scores for different types of restaurants by neighbourhood distress level. In general, neighbourhoods with lower distress levels presented higher (more healthful) NEMS-R scores, for example, significantly higher Facilitators sub-scores (7.37) in low distress level neighbourhoods, and higher Barriers sub-scores (-2.56) (fewer barriers to healthy eating) in mid distress level neighbourhoods. Regular sit-down restaurants located in neighbourhoods with lower distress levels, specifically, had significantly higher Healthy Entrées and Facilitators sub-scores (1.24 and 5.88, respectively) to support healthy eating than those in neighbourhoods with higher distress levels. Similarly, pita and sandwich fast food restaurants had more Barriers (-6.43) hindering healthy eating in high distress level neighbourhoods compared to lower distress level neighbourhoods.

Table 4-4. Comparison of NEMS-R scores by neighbourhood distress level

	Mean NEMS-R Scores (SD)			
	Neighbourhood Distress Level			p-value*
	Low	Mid	High	
NEMS-R total score				
Regular	9.41 (10.217)	7.30 (8.632)	6.04 (6.871)	.341
High-end	NR	7.11 (3.348)	12.00 (-)	NP
Cafeteria	8.67 (.577)	.75 (4.500)	7.00 (4.690)	.062
Chain	25.67 (6.110)	18.20 (10.849)	14.50 (9.874)	.304
Independent	10.00 (1.414)	9.33 (6.583)	7.50 (2.121)	.907
Burger &chicken	13.30 (11.036)	9.85 (8.375)	7.27 (9.300)	.309
Pita &sandwich	22.63 (12.455)	20.13 (13.071)	22.57 (15.153)	.856
Pizza	.60 (9.216)	6.08 (11.008)	-1.70 (7.273)	.152
Ethnic	2.57 (6.373)	6.73 (6.923)	6.00 (8.124)	.441
All	10.35 (11.883)	9.22 (9.864)	7.24 (9.578)	.133
Healthy Entrées sub-score				
Regular	1.24 (1.954)[a]	.59 (1.571)[a]	.24 (.723)[b]	**.043**
High-end	NR	.00 (.000)	.00 (-)	NP
Cafeteria	.00 (.000)	.00 (.000)	.25 (.500)	.463
Chain	3.00 (.000)	2.40 (.894)	2.33 (1.211)	.617
Independent	.00 (.000)	.33 (1.155)	.00 (.000)	.864
Burger &chicken	1.50 (1.080)	1.46 (1.127)	1.20 (1.424)	.796
Pita &sandwich	3.75 (3.196)	3.39 (3.071)	3.86 (3.185)	.923
Pizza	.30 (.949)	1.08 (1.730)	.50 (1.080)	.366
Ethnic	.71 (1.254)	.67 (1.113)	.00 (.000)	.372
All	1.38 (2.009)	1.00 (1.922)	.77 (1.550)	.126
Healthy Side Dishes sub-score				
Regular	1.41 (1.873)	1.89 (2.574)	1.71 (2.598)	.760
High-end	NR	1.89 (2.052)	.00 (-)	NP
Cafeteria	5.00 (3.464)	.75 (1.500)	4.50 (1.732)	.060
Chain	3.00 (.000)	4.20 (4.550)	2.00 (1.549)	.488
Independent	3.00 (.000)	2.75 (3.251)	3.00 (.000)	.990
Burger &chicken	1.80 (1.549)	1.38 (1.981)	1.00 (1.464)	.510
Pita &sandwich	6.00 (2.268)	4.96 (2.325)	4.71 (2.928)	.516
Pizza	.60 (1.265)	.75 (1.357)	.30 (.949)	.686
Ethnic	.43 (1.134)	1.60 (2.501)	1.50 (3.674)	.595
All	2.15 (2.476)	2.23 (2.707)	1.80 (2.523)	.404
Healthy Beverages sub-score				
Regular	5.65 (1.455)	5.70 (1.874)	5.45 (1.324)	.697
High-end	NR	6.00 (1.414)	6.00 (-)	NP

Cafeteria	7.00 (1.732)	5.25 (1.500)	3.75 (2.872)	.206
Chain	6.00 (.000)	6.00 (.000)	6.00 (.000)	-
Independent	6.00 (.000)	5.75 (2.379)	6.00 (.000)	.981
Burger &chicken	6.00 (2.000)	5.31 (2.175)	5.60 (1.920)	.722
Pita &sandwich	6.38 (1.923)	5.87 (1.914)	6.43 (2.707)	.714
Pizza	4.20 (1.549)	5.00 (1.477)	3.60 (1.265)	.089
Ethnic	5.14 (2.268)	6.00 (1.134)	6.50 (1.225)	.265
All	5.60 (1.787)	5.71 (1.777)	5.40 (1.651)	.368
Facilitators sub-score				
Regular	5.88 (7.415)[a]	2.19 (4.561)[b]	2.06 (3.971)[b]	**.011**
High-end	NR	.00 (.000)	3.00 (-)	NP
Cafeteria	1.67 (2.887)	.75 (1.500)	.00 (.000)	.477
Chain	18,67 (6.028)	10.40 (7.668)	10.67 (8.383)	.312
Independent	2.50 (.707)	.75 (2.598)	.00 (.000)	.559
Burger &chicken	13.60 (6.851)	11.62 (4.718)	10.47 (6.046)	.432
Pita &sandwich	12.88 (10.508)	10.87 (10.537)	17.00 (10.263)	.405
Pizza	2.70 (3.592)	6.00 (8.213)	2.90 (4.748)	.362
Ethnic	1.43 (2.992)	3.27 (3.751)	5.00 (3.464)	.209
All	7.37 (8.230)[a]	4.15 (6.801)[b]	5.30 (6.952)[b]	**.010**
Barriers sub-score				
Regular	-3.00 (3.674)	-1.96 (2.772)	-2.33 (2.757)	.379
High-end	NR	- .63 (1.257)	.00 (-)	NP
Cafeteria	-3.00 (3.000)	-3.00 (4.243)	.00 (.000)	.331
Chain	-2.00 (1.732)	-2.40 (1.342)	-3.50 (1.225)	.265
Independent	-1.50 (2.121)	.00 (.000)	-1.50 (2.121)	.062
Burger &chicken	-6.90 (2.025)	-7.38 (2.631)	-8.20 (1.781)	.326
Pita &sandwich	-4.14 (3.182)[a]	-3.00 (3.000)[a]	-6.43 (2.070)[b]	**.032**
Pizza	-5.70 (3.302)	-5.25 (3.646)	-6.60 (3.098)	.646
Ethnic	-3.86 (3.761)	-3.20 (3.489)	-5.00 (4.517)	.619
All	-4.25 (3.418)[a]	-2.56 (3.206)[b]	-4.02 (3.548)[a]	**< .001**
Pricing sub-score				
Regular	-1.76 (1.522)	-1.11 (2.247)	-1.04 (2.169)	.466
High-end	NR	- .16 (1.214)	3.00 (-)	NP
Cafeteria	-2.00 (1.732)	-3.00 (.000)	-1.50 (1.732)	.341
Chain	-3.00 (.000)	-2.40 (1.342)	-3.00 (.000)	.441
Independent	.00 (.000)	- .25 (.866)	- .00 (.000)	.864
Burger &chicken	-2.70 (.949)	-2.54 (1.127)	-2.80 (.775)	.769
Pita &sandwich	-2.25 (1.389)	-1.96 (1.461)	-3.00 (.000)	.198

Pizza	-1.50 (1.581)	-1.50 (1.567)	-2.40 (1.265)	.298
Ethnic	-1.29 (1.604)	-1.60 (1.549)	-2.00 (1.549)	.716
All	-1.90 (1.458)	-1.30 (1.898)	-1.71 (1.919)	.074

NR means there is no high-end sit-down restaurants in neighbourhood with a low distress level
NP Only one high-end restaurant located in high distress level neighbourhoods, one-way ANOVA test were not performed, so were Std. Deviation (-)
* ANOVA main effect significance level comparing NEMS-R scores of each restaurant type by neighbourhood distress level
[a, b] Mean values within a row with unlike superscript letters were significantly different as determined by pairwise comparisons using Tukey's *B post hoc* test ($P<0.05$)

Availability of Healthy and Unhealthy NEMS-R Items

This study compares the differences in the availability of healthy and unhealthy items, as assessed by NEMS-R, by neighbourhood distress level. In general, healthy beverages, such as 100% fruit juice and diet soda, were available in the majority of restaurants (82%, 94%, respectively), and whole-grain bread was offered at approximately one-third of restaurants. But less than 10% of restaurants offered baked chips or had menu notations that encourage healthy requests, and less than one-quarter of the restaurants had main entrées (24%) or main-dish salads (10%) that met the NEMS-R standards of 'healthy'. With respect to unhealthy qualities, the most common finding was combo meal offers that were cheaper than individual items, which were promoted in 63% of restaurants. In addition, about one-third had signs encouraging unhealthy or excessive eating; however, few or no restaurants limited healthy eating through methods such as promoting low-carb entrées (1%), increasing the price of healthy entrées (0%), or charging for shared entrées (1%).

Overall, there were only a few statistically significant differences in choices of healthy and unhealthy items offered in restaurants across neighbourhood distress levels. For example, fewer restaurants in neighbourhoods with a low distress level provided all-

you-can-eat or unlimited trips compared to those in higher distress level neighbourhoods; only restaurants in mid distress level neighbourhoods charged for a shared entrée.

Table 4-5. Comparison of availability of healthy/unhealthy choices by neighbourhood distress level

	Percentage of NEMS-R Item Availability				
	Neighbourhood Distress Level			All	p-value*
	Low	Mid	High		
Healthy Item					
Main dishes/entrées	37%	22%	22%	24%	.468
Main dish salads	13%	11%	7%	10%	.297
Low-fat or fat free salad dressings	17%	13%	13%	14%	.419
Fruits (without added sugar)	10%	12%	6%	10%	.377
Vegetables (non-fried)	18%	21%	20%	20%	.296
Baked Chips	10%	6%	4%	6%	.377
Whole grain bread	33%	35%	31%	34%	.142
100% fruit juice	77%	86%	79%	82%	.121
Low-fat, skim or non-fat milk	10%	11%	7%	10%	.116
Diet soda	93%	93%	97%	94%	.147
Nutrition information on menu or healthy	28%	15%	20%	19%	.695
Nutrition information at point of purchase	37%	17%	27%	23%	.838
Signs encourage healthy eating	37%	17%	22%	22%	.720
Menu notations that encourage healthy requests	10%	9%	8%	9%	.355
Reduced-size portions offered on menu	10%	12%	17%	13%	.275
Smaller portion at reduced price	8%	13%	19%	14%	.212
Unhealthy Item					
Super-sizing, or large sizes encouraged	48%	24%	42%	33%	.661
Menus discourage special requests	5%	8%	8%	7%	.249
All you can eat or unlimited trips	2%[a]	7%[b]	7%[b]	6%	**.056**
Signs encourage unhealthy eating	42%	23%	48%	33%	.361

Signs/banners encourage overeating	40%	23%	36%	30%	.518
Low carbohydrate promotion	2%	1%	1%	1%	.789
Combo meal cheaper than individual items	70%	54%	75%	63%	.197
Healthy entrees cost more than regular ones	0%	0%	0%	0%	-
Charge for shared entrée	0%[a]	2%[b]	0%[a]	1%	**.014**

* ANOVA main effect significance level comparing availability of NEMS-R items by neighbourhood distress level

[a, b] Mean values within a row with unlike superscript letters were significantly different as determined by pairwise comparisons using Tukey's *B post hoc* test ($P<0.05$)

Fast Food Environment for Children

The fast food environment in neighbourhoods for children was measured by the accessibility of fast food outlets around a child's place of residence, and the healthfulness of those outlets, as assessed by mean NEMS-R total scores. Children living in the city had access to an average of .286 (SD .294) fast food outlets within 500m and .531 (SD .320) fast food outlets within 750m network buffer zone of their homes, and the closest outlet where fast food could be purchased was an average of 1058.43 (SD 466.303) metres away from a child's home. The mean NEMS-R scores of fast food outlets for children in Saskatoon were 4.37 (SD 5.912) within 500m and 8.17 (SD 7.885) within 750m buffers around their residence; the mean NEMS-R score of the closest outlet was 16.82 (SD 12.804).

Table 4-6 compares the food environment of fast food outlets for children according to neighbourhood distress level. Approximately half of children (47%) lived in neighbourhoods with a low distress level, and these children had access to fewer fast food outlets within the relevant buffer zones, in addition to living farther from the closest

outlets compared to those in mid (27%) and high distress (26%) level neighbourhoods. In the statistical analysis though, there were no significant differences in fast food environments for children according to their home neighbourhood distress level.

Table 4-6. Accessibility and healthfulness of fast food outlets from children's homes

	Mean Values (SD)				
	Neighbourhood Distress Level			All	p-value*
	Low	Mid	High		
Accessibility					
Number (within 500m)	.204 (.220)	.280 (.296)	.377 (.345)	.286 (.294)	.187
Number (within 750m)	.547 (.256)	.504 (.340)	.540 (.374)	.531 (.320)	.907
Distance (m) to the closest	1153.913 (516.351)	950.104 (399.902)	943.816 (471.221)	1018.323 (468.346)	.283
Healthfulness (mean NEMS-R scores of fast food outlets within the buffer)					
Within 500m	3.03 (4.690)	4.84 (7.341)	5.31 (5.515)	4.37 (5.912)	.450
Within 750m	9.75 (10.283)	7.24 (6.584)	7.43 (6.135)	8.17 (7.885)	.547
The closest	22.21 (16.994)	10.12 (10.488)	13.93 (7.802)	16.82 (12.804)	.090

* ANOVA main effect significance level comparing mean values by neighbourhood distress level

CHAPTER 5
DISCUSSION

The results show that, although the geographic distributions of various restaurant types in Saskatoon neighbourhoods are related (with a cluster in the downtown area, and along major roads and intersections), their proportional distributions significantly differ with respect to neighbourhood distress level. According to NEMS-R results, there are significant differences in the healthfulness of food in different types of restaurants. Specifically, chain coffee shops and pita and sandwich fast food restaurants had higher NEMS-R total scores and Healthy Entrées sub-scores. Burger and chicken, pita and sandwich restaurants, and chain coffee shops rated higher in Facilitators sub-scores. However, lower Barriers sub-scores were found in burger and chicken and pizza fast food restaurants.

Although the trend in the distribution of NEMS-R scores is similar in each distress level of neighbourhoods (Figure 4-3), restaurants within lower distress level neighbourhoods presented higher (more healthful) NEMS-R scores. For example, regular sit-down restaurants located in neighbourhoods with a low distress level had significantly higher Healthy Entrées and Facilitators sub-scores to support healthy eating compared with those within higher distress level neighbourhoods. The comparison of availability in choices between healthy and unhealthy foods in restaurants also indicated differences across neighbourhood distress levels, for example, fewer restaurants providing all-you-can-eat options in low distress level neighbourhoods. While I discovered a trend showing fewer fast food outlets and higher NEMS-R scores in these outlets for children living in

lower distress level neighbourhoods, the differences were not statistically significant by neighbourhood distress level.

Despite the increasing interest in the study of food environments in recent years, few studies have used in-store or in-restaurant measures to characterize the consumer food environment as a whole. In this study, I examined the healthfulness of foods and beverages in restaurants across Saskatoon neighbourhoods, as measured by NEMS-R scores, and relevant results suggest opportunities to improve accessibility, availability, and quality of food and to promote health policies and targeted interventions to support more healthful eating habits among children living in Saskatoon neighbourhoods. The healthier practices, as defined by the NEMS-R, most commonly offered (for example, in at least 80% of restaurants) were the availability of healthy beverages, such as 100% fruit juice and diet soda. Few or no restaurants limited healthy eating through methods such as promoting low-carb entrées, increasing the price of healthy entrées, or charging for shared entrées. However, fewer than a quarter of restaurants had facilitators, such as nutrition information and notations on menus or at point of purchase, to encourage healthy eating, and even fewer offered healthy main dish salads, no sugar-added fruit, or baked chips. On the other hand, cheaper combo meal offers, as one of the unhealthier practices, were promoted in 63% of restaurants.

A recent study (Moudon et al., 2013) using food permit records assessed the relative healthfulness of different types of food establishments and suggested that future research should establish health values of foods in different types of food outlets. The current study assessed almost all of the restaurants (344) in Saskatoon, categorized into sit-down restaurants (178), coffee shops (30), and fast-food restaurants (136). The results

of NEMS-R show that sit-down restaurants have a poorer consumer food environment, indicated by lower NEMS-R total scores, compared to coffee shops and fast food restaurants. These findings are partially coincident with two prior studies (Saelens et al., 2007; Pereira et al., 2014) using the same instrument, both of which found more meals that meet healthy criteria at fast food restaurants compared to sit-down restaurants. Consistent with Saelens and colleagues (2007), I argue there are multiple ways in which different restaurant types either encourage or discourage healthy eating. For instance, using NEMS-R measures, both fast food restaurants and chain coffee shops were more likely to offer healthy entrées and to provide nutrition information and highlight healthy options to facilitate healthy eating compared to sit-down restaurants; however, fast food restaurants were found to have more barriers, such as encouraging large portions, to hinder healthy eating, and to more often offer relative cost savings for combination meals.

The findings of the present study divided into detailed restaurants categories provides more evidence that the food environments within specific types of fast food outlets are more likely to encourage consumers to choose healthy meals. For example, pita and sandwich fast food restaurants rated highest in offering healthy side dishes according to nutritional information or notations (labeled as being more healthy, such as low fat, low calories, or no sugar added) on the menu. Chain coffee shops, which were categorizes as a type of fast food outlet patronized by children due to their low price points, were found to have more facilitators of healthy eating, including nutrition information on menus, reduced-size portions offered, and special requests for modifying entrées encouraged on the menu. As people increase the frequency of eating in restaurants, requiring restaurants to present nutrition information on menus is under

consideration as a potential way to slow the increasing prevalence of obesity. However, studies that have examined how the provision of nutrition information on menus influences purchasing intentions has found that most consumers are unaware of the number of calories or any other nutrition information provided on restaurant menus (Burton, Creyer, Kees, & Huggins, 2006; Wootan & Osborn, 2006). It remains to be determined if the factors assessed by the NEMS-R are actually related to individuals' food choices and the risk of obesity, and whether higher NEMS-R scores in chain coffee shops and pita and sandwich fast food restaurants indicate healthier consumer food environments or simply more extensive provision of nutrition information on restaurant menus, that is not actually used by patrons.

Research has demonstrated that changes in the food environment in North America during the past several decades have contributed to increased rates of childhood obesity, and unhealthy food environments are found more often in socially-distressed neighbourhoods (Ball & McCargar, 2003; Skouteris, McCabe, Swinbure, & Hill, 2010; Cerin et al., 2011; Caspi et al., 2012; Black, Moon, & Baird, 2014). The findings of the present study demonstrate the differences in community and consumer food environments by neighbourhood distress level. This study is among the few characterizing the community food environment in a mid-size Canadian city (Apparicio, Cloutier, & Shearmur, 2007; Hemphill, Raine, Spence, & Smoyer-Tomic, 2008; Pabayo, Spence, Cutumisu, Casey, & Storey, 2012; Smoyer-Tomic et al., 2008). It found that fast food outlets were mainly clustered in or surrounding some of Saskatoon's core neighbourhoods with high distress levels, such as in the Central Business District and along 22nd Street West in Caswell Hill, Riversdale, Westmont and Pleasant Hill, portions

of which were also rated higher in mean food balance ratio (meaning less access to supermarkets compared to greater access to fast food outlets) in the Food Access Report produced by the Saskatoon Health Region (Kershaw et al., 2010). The Report also identified a primary food desert in Saskatoon neighbourhoods, located in high distress level neighbourhoods, and that have lower mean NEMS-R scores as found in this study.

Research on access to fast food and neighbourhood socioeconomic characteristics has resulted in mixed findings. In a systematic review of fast food access studies in the United States in 2011 (Fleischhacker et al., 2011), most of the included research found that access to a greater number of fast food restaurants was more likely in low income areas compared with higher income areas. In contrast, Macintyre and colleagues' research (2008), examining the distribution of food resources by neighbourhood distress in Glasgow, UK, found that residents in more distressed neighbourhoods were not necessarily deficient in access to affordable food meeting current nutritional guidelines (i.e., fresh fruit and vegetables), nor were they particularly exposed to fast food outlets selling high-fat and energy dense food at low prices. One study examining the food outlet environment (including full-service restaurants, fast food restaurants, sandwich restaurants, coffee shops, and convenience stores) across Canada found access to all types of food outlets was not associated with neighbourhood socioeconomic characteristics (Seliske et al., 2009). But a few cities in Canada, such as Edmonton, Alberta (Smoyer-Tomic et al., 2008), Hamilton, Ontario (Latham et al., 2007), and Montreal, Quebec (Apparicio et al., 2007) have demonstrated more distressed neighbourhoods with greater access to fast food compared to more advantaged neighbourhoods. Research on food access in Edmonton, Canada (Smoyer-Tomic et al., 2008), for example, demonstrated

greater exposure to fast food in more distressed neighbourhoods but supermarket exposure was not systematically absent from these neighbourhoods. These discrepancies may in part be due to methodological differences across studies and countries in the definition of 'study areas', or in the measures used to distinguish area-level socioeconomic status (Fleischhacker et al., 2011; Macintyre, 2007).

This study examined the differences in consumer food environments in restaurants by neighbourhood distress level and demonstrated that, in general, neighbourhoods with lower distress levels presented healthier food environments, as indicated by higher NEMS-R scores. For example, restaurants within low distress level neighbourhoods had more facilitators to encourage healthy eating behaviours; restaurants within mid distress level neighbourhoods had fewer barriers to healthy eating. The drill-down analysis of the healthfulness of various restaurant types by neighbourhood distress level provided more evidence in support of the expected direction. Regular sit-down restaurants, for example, had more healthy entrées and facilitators encouraging healthy eating in low distress level neighbourhoods compared to neighbourhoods with higher distress levels. Although they showed higher NEMS-R total scores as a whole, pita and sandwich fast food restaurants located in high distress level neighbourhoods discouraged healthy eating more often, as indicated by lower Barriers sub-scores, compared to those in lower distress level neighbourhoods. I also found more challenges to selecting healthy items in neighbourhoods with higher distress levels, although there were only a few significant differences across neighbourhood distress levels. For instance, more restaurants in high distress level neighbourhoods provided all-you-can-eat or unlimited trips compared to those in low distress level neighbourhoods. Overall, most literature that

assesses consumer food environments has linked the availability of high-quality food to socioeconomic characteristics, with more distressed neighbourhoods having foods of lower quality. Studies in the United States, in particular, have found that the availability of healthy foods, defined as part of the consumer food environment (Glanz et al., 2005), is associated with higher neighbourhood income (Zank et al., 2006; Franco et al., 2008).

Studies examining the relationship between fast food access and socioeconomic factors often use GIS techniques to geocode study participants' homes (or schools) and then geo-locate food outlets in relation to these (Caspi et al., 2012; Engler-Stringer, Le, Gerrard, & Muhajarine, 2014; Fleischhacker et al., 2011). The most common GIS-based measures to capture food access include density, count, proximity, and ratio. The current study explored whether differences exist in geographic accessibility of fast food outlets, measured by numbers (density) and distances (proximity) of fast food outlets, around children's homes. The results found that children in neighbourhoods with a high distress level tended to have more exposure to fast food environments as indicated by greater numbers of fast food outlets within a walkable buffer, and by smaller distances to the nearest fast food outlets. This is consistent with literature from the United States indicating greater access to fast food restaurants for residents living in low income neighbourhoods or neighbourhoods with higher concentrations of ethnic minority groups (Block et al., 2004; Jeffery, Baxter, McGuire, & Linde, 2006; Zenk & Powell, 2008). Consistent with the US literature, a previous study by Macdonald et al. (2007) found significantly greater accessibility to fast food chain restaurants in more distressed areas in England and Scotland. Although research from other countries has documented greater exposure to fast food outlets in neighbourhoods with higher distress levels, little of this

research has focused on children, who may be more vulnerable to increased accessibility to fast food restaurants (Bauer et al., 2009; Beydoun, Powell, Chen, & Wang, 2011). Studies on Canadian children have found that some dimensions of fast food access in neighbourhoods are associated with dietary outcomes, but few of these have linked the fast food environment to neighbourhood socioeconomic characteristics (Hemphill et al., 2008; Smoyer-Tomic et al., 2008; Seliske et al., 2009). In addition, findings of studies using solely GIS-based measures may provide less guidance for planning interventions within restaurants and it has been suggested that it may be important to combine both community and consumer food environment measures to characterize geographic aspects and actual availability in food outlets (Caspi et al., 2012; Engler-Stringer et al., 2014). By combining GIS-based techniques with the assessment of consumer food environments (NEMS-R) in fast food outlets, the current study found both the accessibility and healthfulness of fast food outlets around children's homes were not significantly different across neighbourhood distress levels.

Study Strengths

This study is one of the first, to our knowledge, to characterize community and consumer food environments in restaurants, and to compare these by neighbourhood distress level in a Canadian city. Also it is unique in terms of assessing the healthfulness of food available in nearly all restaurants by different categories in the city as a whole. The instrument used – NEMS-R – is one of the most widely disseminated and validated assessment tools available to evaluate the consumer food environment in restaurants and specifically, has been applied to examine children's menus with high inter-rater reliability (Krukowski et al., 2011). Results from NEMS-R indicated that practices that are more

supportive of healthful eating could be implemented in restaurants in Saskatoon neighbourhoods.

Study Limitations

Despite the strengths of the present study, it is important to also consider its limitations. Although there are several ways to define categories of food outlets, mostly using their own set of features, there is no consensus regarding what these features should be and thus there are no standard definitions to categorize restaurants (Fleischhacker et al., 2011). Future efforts might work towards building consensus on what data sources should be used to determine categories of restaurants to reduce inconsistent findings on food environments. Another limitation involves the use of an automatic geocoding tool (in our case, ArcGIS), which is vulnerable to various types of error that may be introduced during the process of matching addresses to spatial areas. A few studies have reported address match rates (Galvez et al., 2008; Larsen & Gilliland, 2008), but very little is known about matching accuracy or the potential impact of positional errors on research findings relating to food access.

A number of limitations exist when interpreting NEMS-R data. As an observational tool, NEMS-R was designed to evaluate selected attributes that are readily observed as well as relevant to obesity and other chronic diseases. However, there are likely to be other restaurant environment factors of interest to researchers that are not part of the analyses of NEMS-R used in this study (Horacek, 2013; Saelens et al., 2007). NEMS-R is also limited because it is highly dependent on restaurants' provision of explicit information about the nutrition content of food offered. As a result, some restaurants with nutrition information available may easily achieve higher scores

regardless of the real nutritional quality of foods served in those restaurants. For example, prior studies (Saelens et al., 2007; Pereria et al., 2014) using the same instrument found more meals that meet healthy criteria at fast food restaurants compared to sit-down restaurants. However, it is inconclusive whether this finding was due to fast food restaurants actually having more healthy options (which is unlikely) or due to the lack of nutritional information available in other types of restaurants (such as the ones categorized here as sit-down restaurants).

Although the method used in this study for calculating fast food accessibility is straightforward and reliable, it provides less detail about other potentially important factors, such as population density or the history of economic development in a neighbourhood. Specifically, characterizing neighbourhood fast food environments for children by counting the number of fast food outlets within a given area does not take into account population density, which is correlated with neighbourhood food source availability and thus independently related to dietary behaviors. Besides, the spatial analysis of food environments is constrained by the issue that the location of food outlets cannot be independent of the history of economic development. Food store or restaurant mapping, audits and participant interview data reveal that access to healthful foods is associated with intersections of space, race, and class (Black et al., 2014; Caspi et al., 2012; Holsten, 2008). Therefore, research using more complex and sophisticated techniques to assess neighbourhood accessibility to food outlets would provide a useful extension of this exploratory work.

Influences on children's food choices are complex and involve a range of individual, social and environmental influences, such as personal preferences and family-

related factors. This study did not gather information on children's perceptions of fast food environments, or on their preferences, or how they travel and consume food within their food environments. As such, it is possible that families with children who live closest to fast food outlet clusters do not frequent those restaurants even though there may be many close to home, instead choosing to eat somewhere that may be more conveniently located close to school or en route to commonly visited destinations. Or, it is also possible that when children do frequent fast food restaurants and chain coffee shops near their homes, the choices they make are not reflected in the relatively high healthfulness scores some of these locations received. Therefore, without in-depth qualitative research in particular, it is difficult to determine whether the accessibility of fast food outlets around children's residences influences their actual consumption of such foods. Future research is necessary to explore the fast food environment for children in depth by incorporating consumer perceptions and travel patterns and to examine the relation between the presence of fast food outlets in home neighbourhoods and fast food consumption, diet quality, and caloric intake.

CHAPTER 6
CONCLUSIONS

Improving the food environment may be an effective primary prevention strategy to address increased rates of childhood overweight and obesity. This study focused on specific gaps in the Canadian research on food environments and provides more evidence to support intervention strategies to encourage healthy eating behaviours for children living in the city. Using GIS-based measures and NEMS-R, it examined the community and consumer food environments in restaurants by neighbourhoods categorized by distress level and provided information concerning food environments in neighbourhood for children living in Saskatoon. The findings of this study demonstrate that the distribution of restaurants and the healthfulness of foods and beverages in restaurants vary by restaurant types and by neighbourhood distress level. The findings highlight the importance of improving access to healthier food environments, especially for children living in high distress level neighbourhoods, and developing interventions to promote the availability of healthier food items in restaurants, as well as limit unhealthy food items. It could also inform future studies examining factors that may lead to health disparities through its focus on linking food environments with socioeconomic characteristics in Saskatoon's residential neighbourhoods. From the point of view of public policy, this study may help municipal decision-makers better identify ways to alleviate inequalities in access to healthy and unhealthy food. For example, ensuring that fast food restaurants located in high distress neighbourhoods have prominently posted nutrition information, as well as information on how to make healthy choices within them, is one policy change

that could be undertaken. In addition, creating municipal policies that limit the number of new unhealthy food sources such as fast food restaurants that are able to open in high distress neighbourhoods is a possible policy measure that may improve the food environments in these neighbourhoods over time. Municipal governments could also provide education for restaurant owners on how to encourage healthy choices by their customers and other ways they may be able to contribute healthy eating behaviours.

Other initiatives that could be supported include, for example, developing strategies to increase the availability, affordability, and acceptability of healthy foods, such as fruit, vegetables, and whole-grain bread, and develop a range of initiatives or facilitators to encourage healthy eating in restaurants. Future research and evaluation are needed to determine whether these initiatives have a positive impact on consumers' food choices and how these are linked to changes in eating behaviors. Finally, further research should be carried out on the relationship between the presence of fast food outlets in neighbourhoods and eating behaviours of children by incorporating measures of caloric intake, diet quality, and children's perceptions.

References

Amarasinghe, A., D'Souza, G., Brown, C., Oh, H., & Borisova, T. (2009). The influence of socioeconomic and environmental determinants on health and obesity: A West Virginia case study. *International Journal of Environmental Research and Public Health, 6*(8), 2271.

An, R., & Sturm, R. (2012). School and residential neighborhood food environment and diet among California youth. *American Journal of Preventive Medicine, 42*(2), 129-135. doi:http://dx.doi.org/10.1016/j.amepre.2011.10.012

Anderson, T. (2010). *2006 Aboriginal population profile for Saskatoon.* (No. 2010003). Statistics Canada.

Apparicio, P., Cloutier, M., & Shearmur, R. (2007). The case of Montréal's missing food deserts: Evaluation of accessibility to food supermarkets. *International Journal of Health Geographics, 6*, 4.

Austin, B. B., Melly, S. J., Sanchez, B. N., & Patel, A. (2005). Clustering of fast-food restaurants around schools: A novel application of spatial statistics to the study of food environments. *American Journal of Public Health, 95*(9), 1575-81.

Ball, G. D. C., & McCargar, L. J. (2003). Childhood obesity in Canada: A review of prevalence estimates and risk factors for cardiovascular diseases and type-2 diabetes. *Applied Physiology, Nutrition, and Metabolism, 28*, 117+.

Batada, A., Bruening, M., Marchlewicz, E. H., Story, M., & Wootan, M. G. (2012). Poor nutrition on the menu: Children's meals at America's top chain restaurants.

Childhood Obesity (Print), 8(3), 251-254. doi:10.1089/chi.2012.0016; 10.1089/chi.2012.0016

Bauer, K. W., Larson, N. I., Nelson, M. C., Story, M., & Neumark-Sztainer, D. (2009). Socio-environmental, personal and behavioural predictors of fast-food intake among adolescents. *Public Health Nutrition, 12*(10), 1767-1774. doi:10.1017/S1368980008004394

Beydoun, M. A., Powell, L. M., Chen, X., & Wang, Y. (2011). Food prices are associated with dietary quality, fast food consumption, and body mass index among U.S. children and Adolescents1-3. *The Journal of Nutrition, 141*(2), 304-11.

Black, J. L., Carpiano, R. M., Fleming, S., & Lauster, N. (2011). Exploring the distribution of food stores in British Columbia: Associations with neighbourhood socio-demographic factors and urban form. *Health & Place, 17*(4), 961-970. doi:http://dx.doi.org/10.1016/j.healthplace.2011.04.002

Black, C., Moon, G., & Baird, J. (2014). Dietary inequalities: What is the evidence for the effect of the neighbourhood food environment? *Health & Place, 27*(0), 229-242. doi:http://dx.doi.org/10.1016/j.healthplace.2013.09.015

Black, J. L., & Day, M. (2012). Availability of limited service food outlets surrounding schools in British Columbia. *Canadian Journal of Public Health, 103*, 255+.

Bleich, S. N., & Pollack, K. M. (2010). The publics' understanding of daily caloric recommendations and their perceptions of calorie posting in chain restaurants. *BMC Public Health, 10*, 121.

Block, J. P., Scribner, R. A., & DeSalvo, K. B. (2004). Fast food, race/ethnicity, and income: A geographic analysis. *American Journal of Preventive Medicine, 27*(3), 211-217. doi:http://dx.doi.org/10.1016/j.amepre.2004.06.007

Bodor, N. J., Rice, J. C., Farley, T. A., Swalm, C. M., & Rose, D. (2010). Disparities in food access: Does aggregate availability of key foods from other stores offset the relative lack of supermarkets in African-American neighborhoods? *Preventive Medicine, 51*(1), 63-67. doi: http://dx.doi.org/10.1016/j.ypmed.2010.04.009

Boone-Heinonen, J., Gordon-Larsen, P., Popkin, B. M., & Richardson, A. S. (2011). Neighborhood fast food restaurants and fast food consumption: A national study. *BMC Public Health, 11*, 543.

Booth, S., Sallis, J. F., Ritenbaugh, C., Hill, J. O., Birch, L. L., Frank, L. D., & Glanz, K. (2001). Environmental and societal factors affect food choice and physical activity: Rationale, influences, and leverage points. *Nutrition Reviews, 59*(3), S21.

Booth, K. M., Pinkston, M. M., & Poston, W. S. C. (2005). Obesity and the built environment. *Journal of the American Dietetic Association, 105*(5, Supplement), 110-117. doi:http://dx.doi.org.cyber.usask.ca/10.1016/j.jada.2005.02.045

Brissette, I., Lowenfels, A., Noble, C., & Spicer, D. (2013). Predictors of total calories purchased at fast-food restaurants: Restaurant characteristics, calorie awareness, and use of calorie information. *Journal of Nutrition Education and Behavior, 45*(5), 404-411. doi:http://dx.doi.org/10.1016/j.jneb.2013.01.019

Brown, A., & Siahpush, M. (2007). Risk factors for overweight and obesity: Results from the 2001 national health survey. *Public Health, 121*(8), 603-613. doi:http://dx.doi.org/10.1016/j.puhe.2007.01.008

Brownson, R. C., Hoehner, C. M., Day, K., Forsyth, A., & Sallis, J. F. (2009). Measuring the built environment for physical activity: State of the science. *American Journal of Preventive Medicine, 36*(4, Supplement), S99-S123.e12. doi:http://dx.doi.org/10.1016/j.amepre.2009.01.005

Burdette, H. L., & Whitaker, R. C. (2004). Neighborhood playgrounds, fast food restaurants, and crime: Relationships to overweight in low income preschool children. *Preventive Medicine, 38*(1), 57-63. doi:http://dx.doi.org/10.1016/j.ypmed.2003.09.029

Burger, K. S., Cornier, M. A., & Ingebrigtsen, J. (2011). Assessing food appeal and desire to eat: The effects of portion size and energy density. *The International Journal of Behavioral Nutrition and Physical Activity, 8*(1), 101. doi:10.1186/1479-5868-8-101

Burton, S., Creyer, E. H., Kees, J., & Huggins, K. (2006). Attacking the obesity epidemic: The potential health benefits of providing nutrition information in restaurants. *American Journal of Public Health, 96*(9), 1669-1675.

Carroll-Scott, A., Gilstad-Hayden, K., Rosenthal, L., Peters, S. M., McCaslin, C., Joyce, R., & Ickovics, J. R. (2013). Disentangling neighborhood contextual associations with child body mass index, diet, and physical activity: The role of built,

socioeconomic, and social environments. *Social Science & Medicine, 95*(0), 106-114. doi:http://dx.doi.org/10.1016/j.socscimed.2013.04.003

Cash, S. B., Minaker, L. M., & Raine, K. D. (2009). Measuring the food service environment: Development and implementation of assessment tools. *Canadian Journal of Public Health, 100*, 421+.

Caspi, C. E., Sorensen, G., Subramanian, S. V., & Kawachi, I. (2012). The local food environment and diet: A systematic review. *Health & Place, 18*(5), 1172-1187. doi:http://dx.doi.org/10.1016/j.healthplace.2012.05.006

Cassady, D., Housemann, R., & Dagher, C. (2004). Measuring cues for healthy choices on restaurant menus: Development and testing of a measurement instrument. *American Journal of Health Promotion, 18*(6), 444-449.

Cerin, E., Frank, L. D., Sallis, J. F., Saelens, B. E., Conway, T. L., Chapman, J. E., & Glanz, K. (2011). From neighborhood design and food options to residents' weight status. *Appetite, 56*(3), 693-703. doi:http://dx.doi.org/10.1016/j.appet.2011.02.006

Charreire, H., Casey, R., Salze, P., Simon, C., Chaix, B., Banos, A., . . . Oppert, J. (2010). Measuring the food environment using geographical information systems: A methodological review. *Public Health Nutrition, 13*(11), 1773-85. doi:http://dx.doi.org/10.1017/S1368980010000753

Chau, C. N., Zoellner, J. M., & Hill, J. L. (2013). Availability of healthy food: Does block group race and income matter? *Journal of Hunger & Environmental Nutrition, 8*(1), 22-38. doi:10.1080/19320248.2012.758063

Cohen, D. A., Ghosh-Dastidar, B., Beckman, R., Lytle, L., Elder, J., Pereira, M. A., . . . Conway, T. L. (2012). Adolescent girls' most common source of junk food away from home. *Health & Place, 18*(5), 963-970. doi:http://dx.doi.org/10.1016/j.healthplace.2012.06.011

Collins, C. E., Okely, A. D., Morgan, P. J., Jones, R. A., Burrows, T. L., Cliff, D. P., . . . Baur, L. A. (2011). Parent diet modification, child activity, or both in obese children: An RCT. *Pediatrics, 127*(4), 619-627. doi:10.1542/peds.2010-1518

Coveney, J., & O'Dwyer, L. A. (2009). Effects of mobility and location on food access. *Health & Place, 15*(1), 45-55. doi:http://dx.doi.org.cyber.usask.ca/10.1016/j.healthplace.2008.01.010

Cox, N., Eaton, S., Khan, M. A., McKenzie, A., Shaw, J., Simmons, D., & Zimmet, P. (2005). Choice and availability of takeaway and restaurant food is not related to the prevalence of adult obesity in rural communities in australia. *International Journal of Obesity, 29*, 703.

Cummins, S., & Macintyre, S. (2006). Food environments and obesity—neighbourhood or nation? *International Journal of Epidemiology, 35*(1), 100-104. doi:10.1093/ije/dyi276

Davis, B., & Carpenter, C. (2009). Proximity of fast-food restaurants to schools and adolescent obesity. *American Journal of Public Health, 99*(3), 505-10.

Davison, K. K., & Birch, L. L. (2001). Childhood overweight: A contextual model and recommendations for future research. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity, 2*(3), 159-171.

Dean, W. R., & Sharkey, J. R. (2011). Rural and urban differences in the associations between characteristics of the community food environment and fruit and vegetable intake. *Journal of Nutrition Education and Behavior, 43*(6), 426-433. doi:http://dx.doi.org/10.1016/j.jneb.2010.07.001

DeBate, R. D., Koby, E. J., Looney, T. E., Trainor, J. K., Zwald, M. L., Bryant, C. A., & McDermott, R. J. (2011). Utility of the physical activity resource assessment for child-centric physical activity intervention planning in two urban neighborhoods. *Journal of Community Health, 36*(1), 132-140. doi:10.1007/s10900-010-9290-1

Ding, D., Sallis, J. F., Norman, G. J., Saelens, B. E., Harris, S. K., Kerr, J., . . . Glanz, K. (2012). Community food environment, home food environment, and fruit and vegetable intake of children and adolescents. *Journal of Nutrition Education and Behavior, 44*(6), 634-638. doi:http://dx.doi.org/10.1016/j.jneb.2010.07.003

Downs, S. M., Arnold, A., Marshall, D., McCargar, L. J., Raine, K. D., & Willows, N. D. (2009). Associations among the food environment, diet quality and weight status in Cree children in Québec. *Public Health Nutrition, 12*(9), 1504-11. doi:http://dx.doi.org.cyber.usask.ca/10.1017/S1368980008004515

Dubois, L., Farmer, A. P., Girard, M., & Peterson, K. (2007). Preschool children's eating behaviours are related to dietary adequacy and body weight. *European Journal of Clinical Nutrition., 61*(7), 846-855.

Dunn, K. I., Mohr, P., Wilson, C. J., & Wittert, G. A. (2011). Determinants of fast-food consumption: an application of the theory of planned behaviour. *Appetite, 57*(2), 349-357. doi:http://dx.doi.org/10.1016/j.appet.2011.06.004

Duran, A. C., Diez Roux, A. V., Latorre, M. D. O., & Jaime, P. C. (2013). Neighborhood socioeconomic characteristics and differences in the availability of healthy food stores and restaurants in Sao Paulo, Brazil. *Health & Place, 23*(0), 39-47. doi:http://dx.doi.org.cyber.usask.ca/10.1016/j.healthplace.2013.05.001

Edmonds, J., Baranowski, T., Baranowski, J., Cullen, K. W., & Myres, D. (2001). Ecological and socioeconomic correlates of fruit, juice, and vegetable consumption among African-American boys. *Preventive Medicine, 32*(6), 476-481. doi:http://dx.doi.org/10.1006/pmed.2001.0831

Elbel, B., Gyamfi, J., & Kersh, R. (2011). Child and adolescent fast-food choice and the influence of calorie labeling: A natural experiment. *International Journal of Obesity, 35*, 493+.

Ferguson, C. J., Muñoz, M. E., & Medrano, M. R. (2012). Advertising influences on young Children's food choices and parental influence. *The Journal of Pediatrics, 160*(3), 452-455. doi:http://dx.doi.org/10.1016/j.jpeds.2011.08.023

Ferris, M. A. (2011). Preventing obesity in canada's aboriginal children: Not just a matter of eating right and getting active. *The International Indigenous Policy Journal, 2*(1)

Fitzpatrick, M., Fulfrost, B., & Howard, P. H. (2011). Proximity of food retailers to schools and rates of overweight ninth grade students: An ecological study in California. *BMC Public Health, 11*, 68.

Fleischhacker, S. E., Evenson, K. R., Rodriguez, D. A., & Ammerman, A. S. (2011). A systematic review of fast food access studies. *Obesity Reviews, 12*(5), e460-e471. doi:10.1111/j.1467-789X.2010.00715.x

Forsyth, A., Wall, M., Larson, N., Story, M., & Neumark-Sztainer, D. (2012). Do adolescents who live or go to school near fast-food restaurants eat more frequently from fast-food restaurants? *Health & Place, 18*(6), 1261-1269. doi:http://dx.doi.org.cyber.usask.ca/10.1016/j.healthplace.2012.09.005

Fraser, L. K., Clarke, G. P., Cade, J. E., & Edwards, K. L. (2012). Fast food and obesity: A spatial analysis in a large United Kingdom population of children aged 13–15. *American Journal of Preventive Medicine, 42*(5), e77-e85. doi:http://dx.doi.org/10.1016/j.amepre.2012.02.007

Freedman, M. R., & Brochado, C. (2010). Reducing portion size reduces food intake and plate waste. *Obesity (Silver Spring, Md.), 18*(9), 1864-1866. doi:10.1038/oby.2009.480

Frohlich, K. L., Ross, N., & Richmond, C. (2006). Health disparities in Canada today: Some evidence and a theoretical framework. *Health Policy, 79*(2–3), 132-143. doi:http://dx.doi.org.cyber.usask.ca/10.1016/j.healthpol.2005.12.010

Galvez, M. P., Morland, K., Raines, C., Kobil, J., Siskind, J., Godbold, J., & Brenner, B. (2008). Race and food store availability in an inner-city neighbourhood. *Public Health Nutrition, 11*(6), 624-31. doi:http://dx.doi.org/10.1017/S1368980007001097

Gilliland, J. A., Rangel, C. Y., Healy, M. A., Tucker, P., Loebach, J. E., Hess, P. M., . . . Wilk, P. (2012). Linking childhood obesity to the built environment: A multi-level analysis of home and school neighbourhood factors associated with body mass index. *Canadian Journal of Public Health, 103*, S15+.

Glanz, K., Sallis, J. F., Saelens, B. E., & Frank, L. D. (2005). Healthy nutrition environments: Concepts and measures. *American Journal of Health Promotion, 19*(5), 330-333. doi:10.4278/0890-1171-19.5.330

Glanz, K., Sallis, J. F., Saelens, B. E., & Frank, L. D. (2007). Nutrition environment measures survey in stores (NEMS-S): Development and evaluation. *American Journal of Preventive Medicine, 32*(4), 282-289. doi:http://dx.doi.org/10.1016/j.amepre.2006.12.019

Gustafson, A., Hankins, S., & Jilcott, S. (2012). Measures of the consumer food store environment: A systematic review of the evidence. *Journal of Community Health, 37*(4), 897-911. doi:10.1007/s10900-011-9524-x

Han, J. C., Lawlor, D. A., & Kimm, S. Y. (2010). Childhood obesity. *The Lancet, 375*(9727), 1737-1748. doi:http://dx.doi.org/10.1016/S0140-6736(10)60171-7

Haynos, A. F., & O'Donohue, W. T. (2012). Universal childhood and adolescent obesity prevention programs: Review and critical analysis. *Clinical Psychology Review, 32*(5), 383-399. doi:http://dx.doi.org/10.1016/j.cpr.2011.09.006

He, M., Tucker, P., Irwin, J. D., Gilliland, J. A., Larsen, K., & Hess, P. (2012). The influence of local food environments on adolescents' food purchasing behaviors. *International Journal of Environmental Research and Public Health, 9*(4), 1458.

He, M., Tucker, P., Irwin, J. D., Gilliland, J., Larsen, K., & Hess, P. (2012). Obesogenic neighbourhoods: The impact of neighbourhood restaurants and convenience stores on adolescents' food consumption behaviours. *Public Health Nutrition, 15*(12), 2331-2339. doi:10.1017/S1368980012000584

Health Canada. (2013). *Measuring the food environment in Canada.* (No. AL 0900C2). Authority of the Minister of Health. doi:978-1-100-20974-6

Hearst, M. O., Harnack, L. J., Bauer, K. W., Earnest, A. A., French, S. A., & Michael Oakes, J. (2013). Nutritional quality at eight U.S. fast-food chains: 14-year trends. *American Journal of Preventive Medicine, 44*(6), 589-594. doi:http://dx.doi.org/10.1016/j.amepre.2013.01.028

Hemphill, E., Raine, K., Spence, J. C., & Smoyer-Tomic, K. (2008). Exploring obesogenic food environments in Edmonton, Canada: The association between socioeconomic factors and fast-food outlet access. *American Journal of Health Promotion, 22*(6), 426-432.

Heymans, M. W., Leeuwis, F. H., Seidell, J. C., Steenhuis, I. H. M., & Vermeer, W. M. (2011). Small portion sizes in worksite cafeterias: Do they help consumers to reduce their food intake? *International Journal of Obesity, 35*, 1200+.

Hollands, S., Campbell, K. M., Gilliland, J., & Sarma, S. (2013). A spatial analysis of the association between restaurant density and body mass index in Canadian adults. *Preventive Medicine, 57*(4)

Holsten, J. E. (2009). Obesity and the community food environment: A systematic review. *Public Health Nutrition, 12*(03), 397-405. doi:10.1017/S1368980008002267

Horacek, T. (2013). Evaluation of the food store environment on and near the campus of 15 postsecondary institutions. *American Journal of Health Promotion, 27*(4), e81.

Inagami, S., Cohen, D., Brown, A., & Asch, S. (2009). Body mass index, neighborhood fast food and restaurant concentration, and car ownership. *Journal of Urban Health, 86*(5), 683-695. doi:10.1007/s11524-009-9379-y

Inge, T. H., King, W. C., Jenkins, T. M., Courcoulas, A. P., Mitsnefes, M., Flum, D. R., . . . Daniels, S. R. (2013). The effect of obesity in adolescence on adult health status. *Pediatrics, 132*(6), 1098-1104. doi:10.1542/peds.2013-2185

Innes-Hughes, C., Boylan, S., King, L. A., & Lobb, E. (2012). Measuring the food environment in three rural towns in new south wales, Australia. *Health Promotion Journal of Australia, 23*(2), 129-33.

Jago, R., Baranowski, T., Baranowski, J., Cullen, K. W., & Thompson, D. (2007). Distance to food stores & adolescent male fruit and vegetable consumption:

Mediation effects. *The International Journal of Behavioral Nutrition and Physical Activity, 4*(1), 35.

Jeffery, R., Baxter, J., McGuire, M., & Linde, J. (2006). Are fast food restaurants an environmental risk factor for obesity? *International Journal of Behavioral Nutrition and Physical Activity, 3*(1), 2.

Jennings, A., Welch, A., Jones, A. P., Harrison, F., Bentham, G., van Sluijs, E. M. F., . . . Cassidy, A. (2011). Local food outlets, weight status, and dietary intake: Associations in children aged 9–10 years. *American Journal of Preventive Medicine, 40*(4), 405-410. doi:http://dx.doi.org/10.1016/j.amepre.2010.12.014

Jetter, K. M., & Cassady, D. L. (2006). The availability and cost of healthier food alternatives. *American Journal of Preventive Medicine, 30*(1), 38-44. doi:http://dx.doi.org/10.1016/j.amepre.2005.08.039

Keller, K. L., Kuilema, L. G., Lee, N., Yoon, J., Mascaro, B., Combes, A., . . . Halford, J. C. G. (2012). The impact of food branding on children's eating behavior and obesity. *Physiology & Behavior, 106*(3), 379-386. doi:http://dx.doi.org/10.1016/j.physbeh.2012.03.011

Kershaw, T., Creighton, T., & Markham, T. (2010). *Food access in Saskatoon: Community report*. Saskatoon, SK, CAN: Saskatoon Health Region, Public Health Services.

Khan, S., Calloway, S. A., Maida, I. T., & Rakel, D. P. (2012). Dietary and built environment assessment in a Latino community. *American Journal of Health Education, 43*(2), 74-82.

Khan, T., Powell, L. M., & Wada, R. (2012). Fast food consumption and food prices: Evidence from panel data on 5th and 8th grade children. *Journal of Obesity, 2010*, 1-8.

Kipke, M. D., Iverson, E., Moore, D., Booker, C., Ruelas, V., Peters, A. L., & Kaufman, F. (2007). Food and park environments: Neighborhood-level risks for childhood obesity in East Los Angeles. *Journal of Adolescent Health, 40*(4), 325-333. doi:http://dx.doi.org/10.1016/j.jadohealth.2006.10.021

Kirk, S. L., Penney, T. L., & Mchugh, T. F. (2010). Characterizing the obesogenic environment: The state of the evidence with directions for future research. *Obesity Reviews, 11*(2), 109(9).

Krieger, J. W., Chan, N. L., Saelens, B. E., Ta, M. L., Solet, D., & Fleming, D. W. (2013). Menu labeling regulations and calories purchased at chain restaurants. *American Journal of Preventive Medicine, 44*(6), 595-604. doi:http://dx.doi.org/10.1016/j.amepre.2013.01.031

Krieger, N., Waterman, P., Chen, J. T., Soobader, M., Subramanian, S. V., & Carson, R. (2003). Geocoding public health data. *American Journal of Public Health, 93*(5), 699-700.

Krukowski, R. A., Eddings, K., & Smith West, D. (2011). The children's menu assessment: Development, evaluation, and relevance of a tool for evaluating children's menus. *Journal of the American Dietetic Association, 111*(6), 884-888. doi:http://dx.doi.org.cyber.usask.ca/10.1016/j.jada.2011.03.018

Krukowski, R., West, D., Harvey-Berino, J., & Elaine Prewitt, T. (2010). Neighborhood impact on healthy food availability and pricing in food stores. *Journal of Community Health, 35*(3), 315-320. doi:10.1007/s10900-010-9224-y

Kuhle, S., Simen-Kapeu, A., & Veugelers, P. J. (2010). Geographic differences in childhood overweight, physical activity, nutrition and neighbourhood facilities: Implications for prevention. *Canadian Journal of Public Health, 101*, 128+.

Lake, A., & Townshend, T. (2006). Obesogenic environments: Exploring the built and food environments. *The Journal of the Royal Society for the Promotion of Health, 126*(6), 262-7.

Laraia, B. A., Siega-Riz, A. M., Kaufman, J. S., & Jones, S. J. (2004). Proximity of supermarkets is positively associated with diet quality index for pregnancy. *Preventive Medicine, 39*(5), 869-875. doi:http://dx.doi.org/10.1016/j.ypmed.2004.03.018

Larsen, K., & Gilliland, J. (2008). Mapping the evolution of 'food deserts' in a Canadian city: Supermarket accessibility in London, Ontario, 1961-2005. *International Journal of Health Geographics, 7*, 16.

Larson, N. I., Story, M. T., & Nelson, M. C. (2009). Neighborhood environments: Disparities in access to healthy foods in the U.S. *American Journal of Preventive Medicine, 36*(1), 74-81.e10. doi:http://dx.doi.org/10.1016/j.amepre.2008.09.025

Lee, H. (2012). The role of local food availability in explaining obesity risk among young school-aged children. *Social Science & Medicine, 74*(8), 1193-1203. doi:http://dx.doi.org/10.1016/j.socscimed.2011.12.036

Lesser, L. I., Kayekjian, K. C., Velasquez, P., Tseng, C., Brook, R. H., & Cohen, D. A. (2013). Adolescent purchasing behavior at McDonald's and Subway. *Journal of Adolescent Health, 53*(4), 441-445. doi:http://dx.doi.org/10.1016/j.jadohealth.2013.02.014

Lieb, D. C., Snow, R. E., & Deboer, M. D. (2009). Socioeconomic factors in the development of childhood obesity and diabetes. *Clinics in Sports Medicine, 28*(3), 349.

Lisabeth, L. D., Sánchez, B. N., Escobar, J., Hughes, R., Meurer, W. J., Zuniga, B., . . . Morgenstern, L. B. (2010). The food environment in an urban Mexican American community. *Health & Place, 16*(3), 598-605. doi:http://dx.doi.org/10.1016/j.healthplace.2010.01.005

Longacre, M. R., Drake, K. M., MacKenzie, T. A., Gibson, L., Owens, P., Titus, L. J., . . . Dalton, M. A. (2012). Fast-food environments and family fast-food intake in nonmetropolitan areas. *American Journal of Preventive Medicine, 42*(6), 579-587. doi:http://dx.doi.org/10.1016/j.amepre.2012.02.017

Longley, P. A. (2000). The academic success of GIS in geography: Problems and prospects. *Journal of Geographical Systems, 2*(1), 37-42. doi:10.1007/s101090050027

Lucan, S., Barg, F., & Long, J. (2010). Promoters and barriers to fruit, vegetable, and fast-food consumption among urban, low income African Americans-A qualitative approach. *American Journal of Public Health, 100*(4), 631-5.

Lytle, L. A. (2009). Measuring the food environment: State of the science. *American Journal of Preventive Medicine, 36*(4, Supplement), S134-S144. doi:http://dx.doi.org.cyber.usask.ca/10.1016/j.amepre.2009.01.018

Macdonald, L., Cummins, S., & Macintyre, S. (2007). Neighbourhood fast food environment and area deprivation—substitution or concentration? *Appetite, 49*(1), 251-254. doi:http://dx.doi.org/10.1016/j.appet.2006.11.004

Macintyre, S. (2005). Out-of-home food outlets and area deprivation: Case study in Glasgow, UK. *The International Journal of Behavioral Nutrition and Physical Activity, 2*, 16.

Macintyre, S. (2007). Deprivation amplification revisited; or, is it always true that poorer places have poorer access to resources for healthy diets and physical activity? *The International Journal of Behavioral Nutrition and Physical Activity, 4*, 32. doi:10.1186/1479-5868-4-32.

Macintyre, S., Macdonald, L., & Ellaway, A. (2008). Do poorer people have poorer access to local resources and facilities? the distribution of local resources by area

deprivation in Glasgow, Scotland. *Social Science & Medicine, 67*(6), 900-914. doi:http://dx.doi.org/10.1016/j.socscimed.2008.05.029

Magnusson, M. B., Sjöberg, A., Kjellgren, K. I., & Lissner, L. (2011). Childhood obesity and prevention in different socio-economic contexts. *Preventive Medicine, 53*(6), 402-407. doi:http://dx.doi.org/10.1016/j.ypmed.2011.09.019

Malabar, M., & Grant, . (2010). *North end food assessment report: Winnipeg*. Winnipeg, MB, CAN: Food Matters Manitoba.

Mandal, B., & Powell, L. M. (2014). Childcare choices, food intake, and children's obesity status in the United States. *Economics & Human Biology, 14*(0), 50-61. doi:http://dx.doi.org/10.1016/j.ehb.2014.04.001

Mattes, R. (2013). Energy intake and obesity: Ingestive frequency outweighs portion size. *Physiology & Behavior,* doi:http://dx.doi.org/10.1016/j.physbeh.2013.11.012

McIntosh, A., Kubena, K. S., Tolle, G., Dean, W., Kim, M., Jan, J., & Anding, J. (2011). Determinants of children's use of and time spent in fast food and full-service restaurants. *Journal of Nutrition Education and Behavior, 43*(3), 142-149. doi:http://dx.doi.org/10.1016/j.jneb.2010.04.002

McKinnon, R. A., Reedy, J., Morrissette, M. A., Lytle, L. A., & Yaroch, A. L. (2009). Measures of the food environment: A compilation of the literature, 1990–2007. *American Journal of Preventive Medicine, 36*(4, Supplement), S124-S133. doi:http://dx.doi.org/10.1016/j.amepre.2009.01.012

Mehta, N. K., & Chang, V. W. (2008). Weight status and restaurant availability: A multilevel analysis. *American Journal of Preventive Medicine, 34*(2), 127-133. doi:http://dx.doi.org/10.1016/j.amepre.2007.09.031

Meyer, K. A., Guilkey, D. K., Ng, S. W., Duffey, K. J., Popkin, B. M., Kiefe, C. I., . . . Gordon-Larsen, P. (2014). Sociodemographic differences in fast food price sensitivity. *JAMA Internal Medicine, 147*(3), 434. doi:10.1001/jamainternmed.2013.13922

Minaker, L. M., Raine, K. D., Wild, C. T., Nykiforuk, C. I. J., Thompson, M. E., & Frank, L. D. (2013). Objective food environments and health outcomes. *American Journal of Preventive Medicine, 45*(3), 289-296. doi:http://dx.doi.org/10.1016/j.amepre.2013.05.008

Moore, L. V., & Diez Roux, A. V. (2006). Associations of neighborhood characteristics with the location and type of food stores. *American Journal of Public Health, 96*(2), 325-31.

Morland, K. B., & Evenson, K. R. (2009). Obesity prevalence and the local food environment. *Health & Place, 15*(2), 491-495. doi:http://dx.doi.org/10.1016/j.healthplace.2008.09.004

Morland, K., Diez Roux, A. V., & Wing, S. (2006). Supermarkets, other food stores, and obesity: The atherosclerosis risk in communities study. *American Journal of Preventive Medicine, 30*(4), 333-339. doi:http://dx.doi.org/10.1016/j.amepre.2005.11.003

Morland, K., & Filomena, S. (2007). Disparities in the availability of fruits and vegetables between racially segregated urban neighbourhoods. *Public Health Nutrition, 10*(12), 1481-1489. doi:10.1017/S1368980007000079

Morland, K., Wing, S., Diez Roux, A., & Poole, C. (2002). Neighborhood characteristics associated with the location of food stores and food service places. *American Journal of Preventive Medicine, 22*(1), 23-29. doi:http://dx.doi.org/10.1016/S0749-3797(01)00403-2

Navalpotro, L., Regidor, E., Ortega, P., Martínez, D., Villanueva, R., & Astasio, P. (2012). Area-based socioeconomic environment, obesity risk behaviours, area facilities and childhood overweight and obesity: Socioeconomic environment and childhood overweight. *Preventive Medicine, 55*(2), 102-107. doi:http://dx.doi.org/10.1016/j.ypmed.2012.05.012

Ng, C., MSc, Corey, P. N., PhD, & Young, T Kue,MD, DPhil. (2011). Socio-economic patterns of obesity among Aboriginal and non-Aboriginal Canadians. *Canadian Journal of Public Health, 102*(4), 264-8.

Ohri-Vachaspati, P., Lloyd, K., DeLia, D., Tulloch, D., & Yedidia, M. J. (2013). A closer examination of the relationship between children's weight status and the food and physical activity environment. *Preventive Medicine, 57*(3), 162-167. doi:http://dx.doi.org/10.1016/j.ypmed.2013.05.009

Oliver, L. N., & Hayes, M. V. (2005). Neighbourhood socio-economic status and the prevalence of overweight Canadian children and youth. *Canadian Journal of Public Health / Revue Canadienne De Sante'e Publique, 96*(6), 415-420.

O'Loughlin, J., Paradis, G., Meshefedjian, G., & Gray-Donald, K. (2000). A five-year trend of increasing obesity among elementary schoolchildren in multiethnic, low income, inner-city neighborhoods in montreal, canada. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity, 24*(9), 1176-1182.

Osei-Assibey, G., Dick, S., Macdiarmid, J., Semple, S., Reilly, J., Elaway, A., . . . McNeil, G. (2012). The influence of the food environment on overweight and obesity in young children: A systematic review. *2*(6), e001538 -e001538.

Pabayo, R., Spence, J. C., Cutumisu, N., Casey, L., & Storey, K. (2012). Sociodemographic, behavioural and environmental correlates of sweetened beverage consumption among pre-school children. *Public Health Nutrition, 15*(08), 1338-1346. doi:10.1017/S1368980011003557

Papas, M. A., Alberg, A. J., Ewing, R., Helzlsouer, K. J., Gary, T. L., & Klassen, A. C. (2007). The built environment and obesity. *Epidemiologic Reviews, 29*(1), 129-143. doi:10.1093/epirev/mxm009

Park, S., Choi, B. Y., Wang, Y., Colantuoni, E., & Gittelsohn, J. (2013). School and neighborhood nutrition environment and their association with students' nutrition behaviors and weight status in Seoul, South Korea. *Journal of Adolescent Health, 53*(5), 655-662.e12. doi:http://dx.doi.org/10.1016/j.jadohealth.2013.06.002

Pate, R. R., O'Neill, J. R., Liese, A. D., Janz, K. F., Granberg, E. M., Colabianchi, N., . . . Taverno Ross, S. E. (2013). Factors associated with development of excessive

fatness in children and adolescents: A review of prospective studies. *Obesity Reviews, 14*(8), 645-658. doi:10.1111/obr.12035

Pearce, J., Blakely, T., Witten, K., & Bartie, P. (2007). Neighborhood deprivation and access to fast-food retailing: A national study. *American Journal of Preventive Medicine, 32*(5), 375-382. doi:http://dx.doi.org/10.1016/j.amepre.2007.01.009

Penney, T. L., Almiron-Roig, E., Shearer, C., McIsaac, J., & Kirk, S. F. L. (2014). Modifying the food environment for childhood obesity prevention: Challenges and opportunities. *Proceedings of the Nutrition Society, 73*(02), 226-236. doi:10.1017/S0029665113003819

Pereira, R. F., Sidebottom, A. C., Boucher, J. L., Lindberg, R., & Werner, R. (2014). Assessing the food environment of a rural community: Baseline findings from the heart of new ULM project, Minnesota, 2010-2011. *Prev Chronic Dis, 11*, E36. doi:10.5888/pcd11.130291

Poskitt, E. M. E. (2005). Tackling childhood obesity: Diet, physical activity or lifestyle change? *Acta Paediatrica (Oslo, Norway: 1992), 94*(4), 396-398.

Poti, J. M., Duffey, K. J., & Popkin, B. M. (2014). The association of fast food consumption with poor dietary outcomes and obesity among children: Is it the fast food or the remainder of the diet? *The American Journal of Clinical Nutrition, 99*(1), 162-171. doi:10.3945/ajcn.113.071928

Powell, L. M., Wada, R., Krauss, R. C., & Wang, Y. (2012). Ethnic disparities in adolescent body mass index in the united states: The role of parental socioeconomic

status and economic contextual factors. *Social Science & Medicine, 75*(3), 469-476. doi:http://dx.doi.org/10.1016/j.socscimed.2012.03.019

Rahman, T., Cushing, R. A., & Jackson, R. J. (2011). Contributions of built environment to childhood obesity. *The Mount Sinai Journal of Medicine, New York, 78*(1), 49-57. doi:10.1002/msj.20235

Rao, M., Prasad, S., Adshead, F., & Tissera, H. (2007). The built environment and health. *The Lancet, 370*(9593), 1111-1113. doi:http://dx.doi.org/10.1016/S0140-6736(07)61260-4

Razani, N., & Tester, J. (2010). Childhood obesity and the built environment. *Pediatric Annals, 39*(3), 133-9.

Reedy, J., Krebs-Smith, S. M., & Bosire, C. (2010). Evaluating the food environment: Application of the healthy eating index-2005. *American Journal of Preventive Medicine, 38*(5), 465-471. doi:http://dx.doi.org/10.1016/j.amepre.2010.01.015

Riner, M. E., Cunningham, C., & Johnson, A. (2004). Public health education and practice using geographic information system technology. *Public Health Nursing, 21*(1), 57-65.

Rodenburg, G., Kremers, S. P. J., Oenema, A., & Mheen, D. v. d. (2012). Associations of children's appetitive traits with weight and dietary behaviours in the context of general parenting. *Plos One, 7*(12), 1-8. doi:10.1371/journal.pone.0050642

Rushton, G., Armstrong, M. P., Gittler, J., Greene, B. R., Pavlik, C. E., West, M. M., & Zimmerman, D. L. (2006). Geocoding in cancer research: A review. *American*

Journal of Preventive Medicine, 30(2, Supplement), S16-S24. doi:http://dx.doi.org/10.1016/j.amepre.2005.09.011

Saelens, B. E., Chan, N. L., Krieger, J., Nelson, Y., Boles, M., Colburn, T. A., . . . Bruemmer, B. (2012). Nutrition-labeling regulation impacts on restaurant environments. *American Journal of Preventive Medicine, 43*(5), 505-511. doi:http://dx.doi.org/10.1016/j.amepre.2012.07.025

Saelens, B. E., & Glanz, K. (2009). Work group I: Measures of the food and physical activity environment: Instruments. *American Journal of Preventive Medicine, 36*(4, Supplement), S166-S170. doi:http://dx.doi.org/10.1016/j.amepre.2009.01.006

Saelens, B. E., Glanz, K., Sallis, J. F., & Frank, L. D. (2007). Nutrition environment measures study in restaurants (NEMS-R): Development and evaluation. *American Journal of Preventive Medicine, 32*(4), 273-281. doi:10.1016/j.amepre.2006.12.022

Sallis, J. F., & Glanz, K. (2006). The role of built environments in physical activity, eating, and obesity in childhood. *The Future of Children, 16*(1, Childhood Obesity), 89-108.

Sallis, J. F., Saelens, B. E., Frank, L. D., Conway, T. L., Slymen, D. J., Cain, K. L., . . . Kerr, J. (2009). Neighborhood built environment and income: Examining multiple health outcomes. *Social Science & Medicine, 68*(7), 1285-1293. doi:http://dx.doi.org/10.1016/j.socscimed.2009.01.017

Salois, M. J. (2012). The built environment and obesity among low-income preschool children. *Health & Place, 18*(3), 520-527. doi:http://dx.doi.org/10.1016/j.healthplace.2012.02.002

Sánchez, B. N., Sanchez-Vaznaugh, E. V., Uscilka, A., Baek, J., & Zhang, L. (2012). Differential associations between the food environment near schools and childhood overweight across Race/Ethnicity, gender, and grade. *American Journal of Epidemiology, 175*(12), 1284-1293. doi:10.1093/aje/kwr454

Seliske, L. M., Pickett, W., Boyce, W. F., & Janssen, I. (2009). Density and type of food retailers surrounding Canadian schools: Variations across socioeconomic status. *Health & Place, 15*(3), 903-907. doi:http://dx.doi.org/10.1016/j.healthplace.2008.11.001

Serrano, E. L., & Jedda, V. B. (2009). Comparison of fast-food and non-fast-food children's menu items. *Journal of Nutrition Education and Behavior, 41*(2), 132-137. doi:http://dx.doi.org/10.1016/j.jneb.2008.02.005

Shearer, C., Blanchard, C., Kirk, S., Lyons, R., Dummer, T., Pitter, R., . . . Sim, M. (2012). Physical activity and nutrition among youth in rural, suburban and urban neighbourhood types. *Canadian Journal of Public Health, 103*, S55+.

Shier, V., An, R., & Sturm, R. (2012). Is there a robust relationship between neighbourhood food environment and childhood obesity in the USA? *Public Health, 126*(9), 723-730. doi:http://dx.doi.org/10.1016/j.puhe.2012.06.009

Skidmore, P., Welch, A., van Sluijs, E., Jones, A., Harvey, I., Harrison, F., . . . Cassidy, A. (2010). Impact of neighbourhood food environment on food consumption in children aged 9–10 years in the UK SPEEDY (sport, physical activity and eating behaviour: Environmental determinants in young people) study. *Public Health Nutrition, 13*(07), 1022-1030. doi:10.1017/S1368980009992035

Skouteris, H., McCabe, M., Swinburn, B., & Hill, B. (2010). Healthy eating and obesity prevention for preschoolers: A randomized controlled trial. *BMC Public Health, 10*(1), 220.

Smith, D. M., Cummins, S., Taylor, M., Dawson, J., Marshall, D., Sparks, L., & Anderson, A. S. (2010). Neighbourhood food environment and area deprivation: Spatial accessibility to grocery stores selling fresh fruit and vegetables in urban and rural settings. *International Journal of Epidemiology, 39*(1), 277-284. doi:10.1093/ije/dyp221

Smoyer-Tomic, K., Spence, J. C., & Amrhein, C. (2006). Food deserts in the prairies? supermarket accessibility and neighborhood need in Edmonton, Canada. *The Professional Geographer, 58*(3), 307-326. doi:10.1111/j.1467-9272.2006.00570.x

Smoyer-Tomic, K. E., Spence, J. C., Raine, K. D., Amrhein, C., Cameron, N., Yasenovskiy, V., . . . Healy, J. (2008). The association between neighborhood socioeconomic status and exposure to supermarkets and fast food outlets. *Health & Place, 14*(4), 740-754. doi:http://dx.doi.org/10.1016/j.healthplace.2007.12.001

Story, M. T., Kaphingst, K. M., Robinson-O'Brien, R., & Glanz, K. (2007). Creating healthy food and eating environments: Policy and environmental approaches. *Annual*

Review of Public Health, 29(April 2008), 253-272. doi:10.1146/annurev.publhealth.29.020907.090926

Sturm, R., & Datar, A. (2005). Body mass index in elementary school children, metropolitan area food prices and food outlet density. *Public Health, 119*(12), 1059-1068. doi:http://dx.doi.org/10.1016/j.puhe.2005.05.007

Tester, J. M., Yen, I. H., & Laraia, B. (2010). Mobile food vending and the after-school food environment. *American Journal of Preventive Medicine, 38*(1), 70-73. doi:http://dx.doi.org/10.1016/j.amepre.2009.09.030

Timperio, A., Ball, K., Roberts, R., Campbell, K., Andrianopoulos, N., & Crawford, D. (2008). Children's fruit and vegetable intake: Associations with the neighbourhood food environment. *Preventive Medicine, 46*(4), 331-335. doi:http://dx.doi.org/10.1016/j.ypmed.2007.11.011

Townshend, T., & Lake, A. A. (2009). Obesogenic urban form: Theory, policy and practice. *Health & Place, 15*(4), 909-916. doi:http://dx.doi.org/10.1016/j.healthplace.2008.12.002

Tremblay, M. S., PhD. (2007). Major initiatives related to childhood obesity and physical inactivity in Canada: The year in review. *Canadian Journal of Public Health, 98*(6), 457-9.

Van Hulst, A., Barnett, T. A., Gauvin, L., Daniel, M., Kestens, Y., Bird, M., . . . Lambert, M. (2012). Associations between children's diets and features of their residential and

school neighbourhood food environments. *Canadian Journal of Public Health, 103*, S48+.

Vernarelli, J. A., Mitchell, D. C., Hartman, T. J., & Rolls, B. J. (2011). Dietary energy density is associated with body weight status and vegetable intake in U.S. Children1,2. *The Journal of Nutrition, 141*(12), 2204-10.

Vernez Moudon, A., Drewnowski, A., Duncan, G. E., Hurvitz, P. M., Saelens, B. E., & Scharnhorst, E. (2013). Characterizing the food environment: Pitfalls and future directions. *Public Health Nutrition, 16*(07), 1238-1243. doi:10.1017/S1368980013000773

Veugelers, P., Sithole, F., Zhang, S., & Muhajapine, N. (2008). Neighborhood characteristics in relation to diet, physical activity and overweight of Canadian children. *International Journal of Pediatric Obesity, 3*, 152.

Wen, M., & Kowaleski-Jones, L. (2012). The built environment and risk of obesity in the United States: Racial–ethnic disparities. *Health & Place, 18*(6), 1314-1322. doi:http://dx.doi.org/10.1016/j.healthplace.2012.09.002

Wen, S. W., Chen, L., Li, C., Kramer, M. S., & Allen, A. C. (2002). The impact of missing birth weight in deceased versus surviving fetuses and infants in the comparison of birth weight-specific feto-infant mortality. *Chronic Diseases in Canada, 23*(4), 146-151.

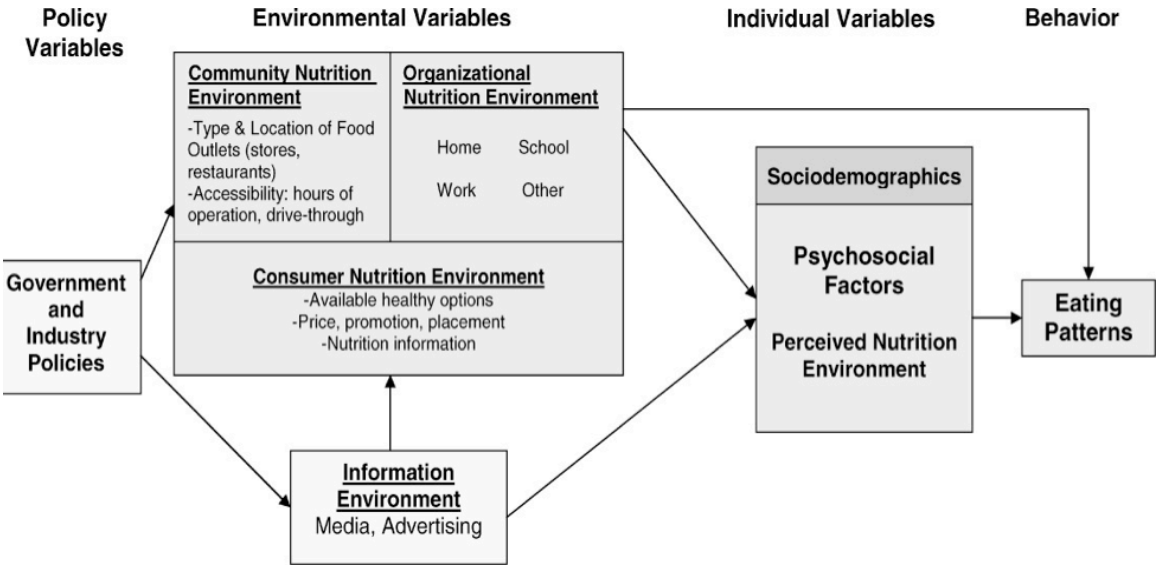
Williams, J. D., Crockett, D., Harrison, R. L., & Thomas, K. D. (2012). The role of food culture and marketing activity in health disparities. *Preventive Medicine, 55*(5), 382-386. doi:http://dx.doi.org/10.1016/j.ypmed.2011.12.021

Willows, N. D. (2005). Determinants of healthy eating in aboriginal peoples in Canada: The current state of knowledge and research gaps. *Canadian Journal of Public Health, 96*, S32-6, S36-41.

Wootan, M. G., & Osborn, M. (2006). Availability of nutrition information from chain restaurants in the United States. *American Journal of Preventive Medicine, 30*(3), 266-268. doi:http://dx.doi.org.cyber.usask.ca/10.1016/j.amepre.2005.10.006

Zenk, S. N., & Powell, L. M. (2008). US secondary schools and food outlets. *Health & Place, 14*(2), 336-346. doi:http://dx.doi.org/10.1016/j.healthplace.2007.08.003

APPENDIX A
MODEL OF COMMUNITY NUTRITION ENVIRONMENTS (Glanz et al., 2005)



APPENDIX B
NUMBERS OF RESTAURANTS IN RESIDENTIAL NEIGHBOURHOODS

	Number of Restaurant Categories								
	Regular	High-end	Cafeteria	Chain	Independent	Burger &Chicken	Pita &Sandwich	Pizza	Ethnic
Adelaide /Churchill	0	0	0	0	0	1	0	1	0
Arbor Creek	0	0	0	0	0	0	0	0	0
Avalon	1	0	0	0	0	0	0	1	0
Brevoort Park	6	1	1	0	0	2	2	1	2
Briarwood	0	0	0	0	0	0	0	0	0
Buena Vista	2	0	0	0	1	0	0	0	0
Caswell Hill	6	1	0	0	0	4	0	2	1
Central Business District	26	12	0	1	7	3	9	1	8
City Park	3	1	1	0	3	0	0	0	0
College Park	7	0	0	1	1	0	1	3	0
College Park East	1	0	0	0	0	0	0	0	0
Confederation Park	0	0	0	0	0	0	0	1	0
Confederation SC	4	0	0	2	0	4	3	3	0
Dundonald	0	0	0	0	0	0	0	1	0
Eastview	1	0	0	0	0	0	0	0	0
Erindale	0	0	0	0	0	0	0	0	0
Exhibition	0	0	1	0	0	0	0	0	0
Fairhaven	0	0	0	0	0	0	0	0	0
Forest Grove	0	0	0	0	0	0	0	1	0
Greystone Heights	3	0	1	0	0	0	0	2	1
Grosvenor Park	10	0	0	0	0	1	3	0	1
Hampton Village	0	0	0	0	0	0	0	0	0
Haultain	1	0	0	0	0	0	0	0	0
Holiday Park	1	0	0	0	0	0	0	0	0
Holliston	6	0	1	1	0	1	1	1	0
Hudson Bay Park	2	0	1	0	0	0	0	0	0
Kelsey Woodlawn	5	0	0	1	0	1	2	0	0
King George	0	0	0	0	0	0	0	0	0
Lakeridge	0	0	0	0	0	0	0	0	0
Lakeview	3	0	0	0	0	0	0	1	0
Lakewood SC	1	0	0	0	1	0	1	1	0
Lawson Heights	0	0	0	0	0	0	0	0	0

Lawson SC	4	0	1	1	0	3	3	2	2
Massey Place	0	0	0	0	0	0	0	0	0
Mayfair	7	0	0	1	0	2	0	0	2
Meadowgreen	1	0	0	0	0	0	0	0	0
Montgomery Place	0	0	0	0	0	1	0	0	0
Mount Royal	2	0	0	0	0	0	0	1	1
North Park	1	0	0	0	0	0	0	0	0
Nutana	9	4	0	0	0	0	2	0	0
Nutana Park	0	0	0	0	0	0	0	0	0
Nutana SC	5	0	0	0	1	2	1	0	2
Pacific Heights	0	0	0	0	0	0	0	0	0
Parkridge	0	0	0	0	0	0	0	0	0
Pleasant Hill	6	0	0	1	0	2	1	2	0
Queen Elizabeth	0	0	0	0	0	0	0	0	0
Richmond Heights	1	0	0	0	0	0	0	0	0
River Heights	0	0	0	1	0	0	0	2	0
Riversdale	6	0	2	1	1	0	0	1	0
Silverspring	0	0	0	0	0	0	0	0	0
Silverwood Heights	0	0	0	0	0	0	0	0	0
Sutherland	4	0	0	1	1	1	1	1	2
The Willows	0	1	0	0	0	0	0	0	0
University Heights SC	4	0	1	1	0	4	5	1	1
Varsity View	3	0	0	1	1	0	0	0	0
Westmount	3	0	0	0	0	0	0	0	0
Westview	0	0	0	0	0	0	0	0	0
Wildwood	2	0	1	1	0	5	2	2	5
Willowgrove	0	0	0	0	0	0	0	0	0

APPENDIX C
NEIGHBOURHOOD DISTRESS VARIABLES AND RANKINGS

Neighbourhood	**Distress Variable (Z-score)**			
	Low Income Household	*Low Education Attainment*	*Unemployment*	*Z-Total*
		Low Distress Level		
Willowgrove	-1.077	-1.029	-1.241	-3.347
Silverspring	-.869	-.629	-1.185	-2.683
Arbor Creek	-.924	-1.255	-.483	-2.663
Buena Vista	-.628	-.905	-1.070	-2.602
Adelaide /Churchill	-.704	-.481	-1.410	-2.595
Lakeridge	-.934	-.794	-.817	-2.545
Erindale	-.978	-.537	-.848	-2.363
Briarwood	-.825	-1.043	-.483	-2.351
River Heights	-.726	-.862	-.733	-2.321
Lakewood SC	-.332	-1.577	-.368	-2.278
University Heights SC	-1.077	-.134	-.989	-2.199
Nutana Park	-1.077	-.764	-.062	-1.904
Lakeview	-.584	-.475	-.677	-1.736
College Park East	-.474	-.449	-.733	-1.657
Silverwood Heights	-.682	-.469	-.455	-1.607
Haultain	-.255	-.725	-.596	-1.576
Lawson Heights	-.321	-.733	-.483	-1.537
Queen Elizabeth	-.551	-.490	-.483	-1.525
Wildwood	-.507	-.493	-.483	-1.484
Greystone Heights	.052	-.702	-.789	-1.440
		Mid Distress Level		
Montgomery Place	-.912	-.381	-.116	-1.409
Eastview	-.562	-.104	-.733	-1.399
Nutana	-.266	-1.042	-.034	-1.342
The Willows	-1.077	-1.967	1.736	-1.307
City Park	-.343	-.756	-.034	-1.133
Holliston	-.102	-.834	-.088	-1.023
Central Business District	-.759	-.052	-.088	-.899
Parkridge	-.167	.040	-.764	-.892
Avalon	-.606	.076	-.256	-.786
Westview	-.474	.374	-.677	-.777
Dundonald	-.189	-.095	-.368	-.652
Brevoort Park	-.244	-.377	.025	-.596
Varsity View	.194	-1.007	.218	-.595
Grosvenor Park	.446	-.806	-.116	-.476
Forest Grove	-.014	-.352	.025	-.341

North Park	-.321	-.233	.277	-.276
Sutherland	.150	-.614	.193	-.271
College Park	.118	-.334	.078	-.138
Lawson SC	-.693	1.216	-.649	-.126
Hampton Village	.567	-.370	-.256	-.060
		High Distress Level		
Exhibition	.282	-.002	-.315	-.035
Pacific Heights	-.233	.751	-.368	.150
Fairhaven	.107	.813	-.315	.605
Holiday Park	-.091	.794	.193	.896
Hudson Bay Park	-.408	1.304	.165	1.060
Confederation Park	.392	.927	-.144	1.175
Caswell Hill	.939	.204	.053	1.196
Richmond Heights	-.408	.607	1.484	1.683
Mayfair	.830	1.012	-.062	1.780
Mount Royal	.392	1.621	.218	2.230
Meadowgreen	1.750	1.611	-.062	3.299
Massey Place	1.454	.768	1.144	3.366
Confederation SC	2.473	.837	.527	3.837
King George	1.290	1.522	1.175	3.988
Nutana SC	-.102	2.417	2.382	4.698
Westmount	2.309	1.523	.895	4.727
Kelsey Woodlawn	1.608	.687	3.308	5.603
Pleasant Hill	3.186	2.578	2.382	8.146
Riversdale	2.956	2.192	3.361	8.509